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MEMORANDUM

STATISTICAL METHODS FOR IMPROVING THE ASSESSMENT OF RECRUITING MARKET CONDITIONS

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Director
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STATISTICAL METHODS FOR IMPROVING THE ASSESSMENT OF RECRUITING MARKET CONDITIONS

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ABSTRACT

This research memorandum quantifies historical seasonal patterns in recruiting statistics and shows them to have evolved over time. Decline in seasonal variation dates from 1978 to 1980 for various measures of recruiting flows. Deseasonalized versions of these recruiting statistics are produced for use in econometric time-series models. The results provide a benchmark for gauging the seasonal component of Navy recruiting goals and achievements.

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INTRODUCTION

BACKGROUND

Seasonal patterns in recruiting reflect recruit preferences concerning the timing both of decisions about employment choice and of entrance into military service. The Navy's Delayed Entry Program (DEP) allows recruits to separate these decisions by signing an enlistment contract in January, for example, and entering military service the following June. Observed seasonal patterns are also influenced by Navy policies and goals concerning the number of enlistment contracts and accessions for each month of the year. The purpose of this research memorandum is to set forth the historical seasonal patterns of recruiting in a quantitative fashion and to outline various policies affecting recruiting and retention from this perspective.

The process of seasonal adjustment is important to an understanding of cycles in the recruiting market, which are believed to be related to business cycles in general. Accounting for seasonal variation associated with the above preferences is necessary to proper interpretation of whether the recruiting cycle is currently on an upward swing, downward swing, or at a turning point. Coping with changes in the seasonal pattern is necessary for analysis of historical data. As the Organization for Economic Cooperation and Development states:

> No government, economic group or individual who is interested in the current economic situation can afford to be without seasonal adjustment for those series that are of general interest. It is correct and usually persuasive to say that with seasonal adjustment one can know what is going on in the economy six months earlier than those using unadjusted data [1, p. 148].

The time series for which seasonal adjustment is considered includes various measures of the flow of recruits. Enlistment contracts are the number of obligations for service acquired by recruiters during a month. Some of these enlistment contracts actually begin service during the month in which the obligation is signed. These contracts are called direct shipments. Those enlistment contracts that are to begin in future months are additions to DEP. Total accessions during a month consist of direct shipments plus recruits from DEP who reach their contracted shipment date during the month (shipments from DEP).

Recent concern of Navy manpower planners with the seasonal pattern of accessions and its relation to the use of recruiting and training resources is particularly relevant to this analysis. Any attempt to level-load accessions over the year may result in higher recruiting costs and a lower average quality of accessions during the year. This possibility was recognized in the fall of 1985 with the implementation of the Targeted Enlistment Bonus (TEB) test for Nuclear Field accessions. The TEB has seasonally variable bonuses that range from a low of $3,750 in the summer months to a high of $6,000 in the spring months. Because other Navy enlistment programs have similar seasonal preferences but no seasonal compensation for off-peak accession, attempting to level-load accessions is likely to result in increased recruiting effort or lower average retention rates of those accessed in the seasonal troughs.

TECHNIQUES

Interest in statistical methods for separating the variance of an economic time series into trend, cycle, seasonal, and irregular components has a long history.[1] This paper uses techniques developed for use with economic data, as well as methods adapted from other disciplines to divide Navy recruiting data into trend-cycle, seasonal, and irregular components. Though four methods are tried, only two are pursued to the point of developing deseasonalized versions of Navy recruiting data: the Census X-11 technique (described below) and a frequency domain procedure based on spectral analysis, which decomposes the variation of a time series into the relative contributions of oscillations of various frequencies.[2]

The Census X-11 technique provides measures of the seasonal pattern in the time rather than frequency domain. It also calibrates changes in the magnitude and phasing of these patterns. In the context of Navy recruiting data, a changing seasonal pattern has two possible sources. One is associated with Navy policy decisions that affect the seasonal patterns of accessions or enlistment contracts. To the extent that the Navy prefers less seasonal patterns, it may alter monthly quotas to reflect this preference when the costs of doing so are perceived to have fallen. The other possible source is associated with changing seasonal patterns in the civilian labor market or changing seasonal preferences among potential recruits. Unfortunately, the techniques used in this analysis do not allow the statistical separation of these two types of influences. Though these factors cannot presently be quantified, it is believed that the second source of changes in seasonal patterns is relatively minor. Thus, measured changes in the pattern are attributed primarily to changes in Navy contract and accession policy.

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1. An excellent review of this history appears in Chapter 1 of [1].
2. The fundamental technique here is Fourier analysis, which Feynman [2, Chapter 50, p. 5] likens to trying to determine the recipe for a cake given only the cake itself.

RESULTS

The frequency domain procedure indicates that enlistment contracts that are either additions to DEP or high Armed Forces Qualification Test (AFQT) group accessions are characterized to a greater extent by relatively long cycles of 4 years or more than are enlistment contracts, per se. Accession goal and changes in the size of DEP are dominated by seasonal cycles of a 12-month period. The largest seasonal component of enlistment contracts that are additions to DEP has a 6-month period, as estimated by the frequency domain procedure.

The extent of recent level-loading of accessions is determined primarily by Navy policy and is readily apparent. The trend toward level-loading begins to evidence itself by 1980 for each month. The seasonal fluctuation for net contracts is also smaller in the recent period. April and May, which are the least productive recruiting months, show a reduced seasonal trough, and the summer months (July, August, and September) show a decline in their seasonal components. Recent enlistment contracts show a heavier seasonal concentration in the October-through-February period. Associated with these changes are changes in the seasonal pattern of additions to DEP. The seasonal variation in additions to DEP experienced a substantial overall decline, concentrated in the period of 1978 through 1981. The seasonal components of the peak months of December through March are lower, and the months of September through November are higher. This is suggestive of a change in the timing of recruiting effort and the possibility of a longer average stay in DEP in the period since 1981.[1]

The primary products of this analysis are seasonally adjusted versions of recruiting data for use in econometric time series studies of recruiting. Both the exposition and comparison of techniques, and the seasonally adjusted data are intended for the use of CNA analysts in future studies.

---

1. This apparent longer average stay in DEP since 1981 may be associated with a second set of observations based on the deseasonalized data. The large and steady buildup of DEP from 1981 through 1983 appears to be a result of (1) a high and steady flow of net contracts at a seasonally adjusted monthly rate about 1,000 higher than the trough of 1978 and 1979, and (2) reduction of accession goal of about the same magnitude. It is likely that labor market conditions related to the business cycle are largely responsible for both facts since reduced accession goals (in the absence of the shrinking force) are probably due to the relatively high retention rates of the existing enlisted force during this period.

PRODUCTION SUMMARY DATA

Navy Recruiting Command Production Summaries (PS) date back to March 1979, and the antecedent (the Program Analysis Report) covers the period of the All-Volunteer Force (AVF) back to July 1973. These monthly summaries are relatively complete descriptions of the numbers and types of recruits either accessing (shipping) or signing contracts within a calendar month. They also contain information on the stocks and flows of recruits in DEP. The data are compiled by Navy Recruiting Command from the PRIDE (Personalized Recruiting for Immediate and Delayed Entry) interactive reservation system that recruiters use to reserve training seats for individuals.[1] The key series to be analyzed are described here. Most of the series are measures of the number of recruits of various types who either reside in the DEP stock or are moving through the contract or accession stages of the recruiting process. Individual decisions cannot be analyzed with such data, though much can be learned from the behavior of the aggregates.

The driving force behind the levels and changes in these measures of recruiting activity is the Navy's accession plan for each type of recruit. Attention is focused here on the largest component of the overall accession plan--USN non-prior-service males. The PS information on accessions within the month is provided by field (e.g., nuclear), program (e.g., school guarantee), and geographic area, including breakdowns by AFQT group and high school degree. The data on the DEP are also provided in terms of expected accession month, high school degree status, and AFQT group status of those in DEP since January 1984.

The number of enlistment contracts reported in the PS are net of attrition from the DEP. The fundamental accounting relations between net contracts and the DEP are the following:

$$\text{Net contracts} = \text{Direct ship contracts} + \text{Net additions to DEP} \quad (1)$$
$$\text{Change in DEP} = \text{Additions to DEP} - \text{Shipments from DEP}. \quad (2)$$

All new contracts add 1 to either the direct ship category or the additions to DEP category. Attritions from DEP subtract 1 from the net additions to DEP category and 1 from the net contracts category. The difference between additions to DEP and shipments from DEP is the change in the DEP since the end of the previous calendar month. Unfortunately, these series are calculated in different ways at different times. Beginning in January 1984, the calculation of direct shipments was altered. Shipments from DEP for which there was some change in the contract, e.g., field or program, were apparently counted as direct ships but not as new net contracts. Thus, the mix between direct ships and additions to DEP changed markedly, solely as a result of this

1. See [3] for a description of the PRIDE data.

accounting change. In August 1985, the PS reverted to the definition used before January 1984, with direct ship contracts defined as those who sign a contract and ship within the same calendar month.[1]

The analytical problems caused by this change can be addressed by calculating a new series for direct ships and additions to DEP from other data provided in the PS. The PS contains a set of time series on the number of recruits scheduled to ship in each of the next 12 months. In the period prior to the definition change, there is a close correspondence between the number scheduled to ship in the following month and the number reported to have shipped (table A-1 of the appendix). Subtracting the difference between the number scheduled to ship and those actually shipped from DEP from the number reported as direct ships between January 1984 and August 1985 leaves an estimate of direct ships consistent across the definition change. The measurement error arising from this adjustment comes from the interaction of two offsetting sources, DEP attrition and unexpected shipments from DEP. In the absence of the definition change, the number actually shipped from DEP may differ from the number scheduled because (1) individuals attrite from the DEP in the month they are supposed to ship and are not replaced by other unexpected DEP shipments, or (2) individuals not scheduled to ship until a later month are shipped in the current month, in excess of any DEP attrition in the current month. The difference can be termed net DEP shipment attrition in the current month. The adjustment described implicitly assumes that this net attrition is zero.

The unobservable measurement error tends to understate "true" direct ships, especially when net attrition from expected DEP shipments in the current month is large. To the extent that this attrition varies with the recruiting cycle, the adjusted series of direct ships does not reflect the full extent of this cyclic variation. Because net contracts are unchanged, additions to DEP must be reduced 1 for 1 as direct ships are increased to maintain the accounting identity (1). Consistent with the above adjustment is one for shipments from DEP that measures it as those scheduled to ship as of the previous month. The measurement errors resulting from the above set of adjustments are much less serious than those resulting from the definition change and allow the analysis to cover the entire period, including the most recent. Note that two important quantitative series--net contracts and change in the DEP--are unaffected by the definition change.

The quality measures considered in this paper deal with accessions and the DEP. Change in the average quality of new recruits is an equilibration mechanism in which recruits of lower quality are substituted for those of higher quality when the recruiting market declines, i.e., the quantity and quality measures of recruiting performance are closely

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1. Several efforts to verify the direct ship totals from individual PRIDE data have not been successful.

related. The traditional measures of quality are the percentage of recruits with a high school diploma (HSD) and the various AFQT Categories.

The period of analysis includes that when the Armed Services Vocational Aptitude Battery (ASVAB) was improperly scored, making necessary an adjustment to the mental group percentages in FY 1977 through 1980. The adjustment is done using mental group percentages reported in [4, p. 69]. Adjusted mental group percentages of USN NPS male accessions are reported in table A-4 of the appendix.

One benefit of the 1984 revision of the PS is the inclusion of DEP quality indicators for all individuals in the one-Navy DEP by month, as shown in table 1. Quantity and quality decline over the period, with the percentage decline in the upper AFQT Categories being half as great as the percentage decline in the size of the one-Navy DEP. Note that between September 1984 and January 1985, quantity held roughly constant while the percentage of upper AFQT Categories declined rapidly. Thereafter, quantity declines by about 15 percent, and the percentage of upper AFQT Categories is roughly constant. It appears that the recent accession goal of 59 percent of total accessions from AFQT Categories II through IIIA may be having a negative effect on the ability of recruiters to obtain new enlistments.

TABLE 1

ONE-NAVY DEP QUALITY INDICATORS BY MONTH[a]

Year-month	Number	HSD (percent)	AFQT I-IIIA (percent)	AFQT IV (percent)
84-1	45,165	98.5	70.1	6.7
84-2	45,700	98.4	69.4	7.1
84-3	44,324	98.4	69.0	7.4
84-4	43,225	98.7	68.2	7.9
84-5	41,944	98.6	67.1	8.6
84-6	39,975	98.7	66.6	8.5
84-7	37,872	98.9	66.4	8.4
84-8	37,061	98.6	65.8	8.7
84-9	36,649	98.0	65.1	9.1
84-10	36,585	97.6	64.2	9.9
84-11	36,134	97.3	62.9	10.1
84-12	35,844	97.0	62.0	10.3
85-1	36,844	96.3	61.1	10.3
85-2	36,093	96.1	61.4	9.9
85-3	35,856	96.2	61.6	9.7
85-4	36,020	96.8	61.0	10.0
85-5	36,252	97.1	60.5	10.2
85-6	35,012	97.3	60.5	9.9
85-7	33,974	96.0	60.6	9.6
85-8	32,118	94.8	60.8	9.2
85-9	30,865	93.3	60.3	9.6

a. One-Navy DEP includes all individuals in the DEP, not just non-prior-service males.

SEASONAL ADJUSTMENT

INTRODUCTION

Seasonal adjustment involves estimating and removing an unobservable seasonal component S_t from an observable series Z_t, where the t indexes time periods. The unobservable components interpretation of seasonal adjustment is discussed in [1] and the references contained therein. The objective is to decompose the observed variance of a time series into trend-cycle, seasonal, and irregular components, e.g.,

$$Z_t = T_t \times S_t \times e_t \ ,$$

where T_t is the trend-cycle component, S_t is the seasonal component, and e_t is the irregular component. This unobservable components model for Z_t assumes that the seasonal component is proportional to the level of the trend-cycle.[1]

There are four commonly used approaches to the problem of decomposing time series variance into the unobservable trend-cycle, seasonal and irregular components:

- Regression techniques
- Autoregressive Integrated Moving Average techniques
- Smoothing techniques
- Spectral techniques.

REGRESSION APPROACH TO DESEASONALIZATION

This approach typically models an additive rather than a multiplicative decomposition of the trend-cycle, seasonal, and residual components. The trend-cycle component is usually modeled with a linear or quadratic polynomial in t, and the seasonal components by seasonal indicators of the (0,1) type or by trigonometric functions of the

---

1. Another common procedure is to additively separate the components,

$$Z_t = T_t + S_t + e_t \ .$$

For more detailed discussion of seasonal adjustment techniques, see [1, 5, 6, 7, and 8] and the references therein.

seasonal period.[1] A typical model with seasonal indicators using monthly data would be

$$Z_t = b_0 + b_1 t + \sum_{i=1}^{11} \delta_i IND_{it} + e_t \quad ,$$

where $IND_{it} = 1$ if observation t of IND_{it} is a period that corresponds to the season indicated by IND_i, and $IND_{it} = 0$ otherwise. The seasonally adjusted value in period t is given by

$$Z_t - \sum_{i=1}^{11} \hat{\delta}_i \, IND_{it} \quad ,$$

where the $\hat{\delta}_i$ are estimated by ordinary least squares.

These models are referred to as globally constant seasonal models because the estimated seasonal pattern is not allowed to change over time. This fact makes them particularly unsuitable for modeling the seasonal pattern of recruit accessions. A generalization to allow the seasonal and trend-cycle components to vary over time produces a class of seasonal models that have locally constant seasonal components. The seasonal and trend-cycle components are adjusted each period (or season) by smoothing factors that weight the past and present differently.[2] A simple specification that allows for changing seasonal components is to allow for interaction between the seasonal and time-trend variables in an ordinary least squares regression. It is a convenient method for determining whether seasonal amplitudes are changing through time.

To illustrate the changing seasonal patterns in USN NPS male recruiting, versions of both the globally and locally constant regression models are presented in the appendix, tables A-6 and A-7. The results indicate a reduction in seasonal amplitude for those recruiting series.

---

1. The trigonometric models of the seasonal component are various forms of the following:

$$S_t = \sum_{i=1}^{M} A_i \sin \frac{2\Pi i}{S} t + \Phi_i \quad ,$$

where M is the number of sine functions in the linear combination, A_i is the amplitude of the ith harmonic, $f_i = 2\Pi i/S$ is the frequency of the ith harmonic, and Φ_i is the relevant phase shift. See [8] for applications.

2. For a description of such a procedure, see [8, pp. 179-180].

TIME-SERIES (ARIMA) MODELS AND FORECASTS

Time-series models provide a relatively sophisticated procedure for extrapolating the observed history of a time series. These procedures assume that there is an underlying stochastic process generating the time series that can be statistically characterized and estimated. An example of such a stochastic process is a random walk, where the random variable z_t is given by

$$z_t = z_{t-1} + \varepsilon_t,$$

and each successive ε_t is drawn from a probability distribution with mean 0. The underlying stochastic process is assumed to be invariant with respect to time.

ARIMA models constitute a wide class of time-series models having a rigorous statistical structure that is treated carefully in various texts [8, 9, 10].[1] The following overview of these procedures cannot be self-contained. It provides, rather, the flavor of the application of such models to readers who are unfamiliar with these techniques.

Application of the ARIMA methods proceeds in three stages: identification, estimation, and diagnostic checking, which are typically implemented in an iterative loop until a suitable model for the series is discovered. The identification of an appropriate statistical process involves a significant amount of judgement by the analyst. The inputs to this stage are the estimated autocorrelation and partial autocorrelation functions of the time series along with an analysis (usually nonrigorous) of its stationarity. If the series exhibits a changing mean (trend) or variance, it must be transformed to a stationary series before the remainder of the model is specified. Trends are eliminated by differencing the series. Logarithmic and power transformations of a series are generally used to achieve a relatively constant variance.

Given a series with roughly constant mean and variance, the current value of the series is then modeled as nonlinear function of past values of the series, and current and past values of random variables that are independent are identically and normally distributed with mean 0 and standard deviation σ. The choice of which past values to include in the model is the heart of the identification process[2] and is based on a number of rules regarding the estimated autocorrelation and partial autocorrelation functions.

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1. These texts should be consulted for detailed explanation of the terms and procedures used below.
2. The general presumption in the literature is that, subject to some other criteria, the fewer the terms, the better. This is the principle of parsimony.

The estimation stage proceeds by implementing an iterative maximum likelihood, or nonlinear least squares, estimation procedure found in various statistical analysis packages such as [11]. Often, estimation of a particular model will converge very slowly, if at all. For each candidate model, the results of the maximum likelihood or nonlinear least squares estimation are subjected to the following criteria:

- Parsimony of model structure (fewer included terms are better)

- Stationarity and invertibility of the model (mathematically necessary)

- Significance and correlation of model coefficients (robustness of estimates)

- Autocorrelations of model residuals (adequacy of model)

- Fit of model (variance of forecast errors).

The results of these tests of model performance are then used to suggest new models for estimation until the analyst is satisfied with one. The multiplicity of criteria implies an indeterminancy of model selection, and the search for a good model often ends with some uncertainty. Provided that the resulting models are well specified, ARIMA forecasts have minimum mean square forecast error among those produced by univariate methods.

Two shortcomings of univariate ARIMA models are the relative inability to forecast turning points in cyclical series and the inability to relate changes in the series to changes in other variables that may influence or otherwise be associated with changes in the subject series. It is possible, though difficult, to use ARIMA methods to decompose time-series variance into trend-cycle, seasonal, and irregular components. An ARIMA-based decomposition is described in [12], but not implemented here. The ARIMA models estimated below have terms that capture seasonal variation in the series, but not in the sense of the unobserved components models discussed above.

The quantity type series, including accession goal, contracts, additions to DEP, and change in DEP, have seasonal components that appear to change over time, and ARIMA models that include both seasonal and nonseasonal components are investigated. Plots of the data (figures 1 through 3) show that, with the exception of accession goal, the variables have roughly constant total variance.[1] Unreported regression results for accession goal, contracts, and additions to DEP against a time trend show the trend to be significant. This indicates

1. The spike in December 1976 is associated with the demise of the GI Bill.

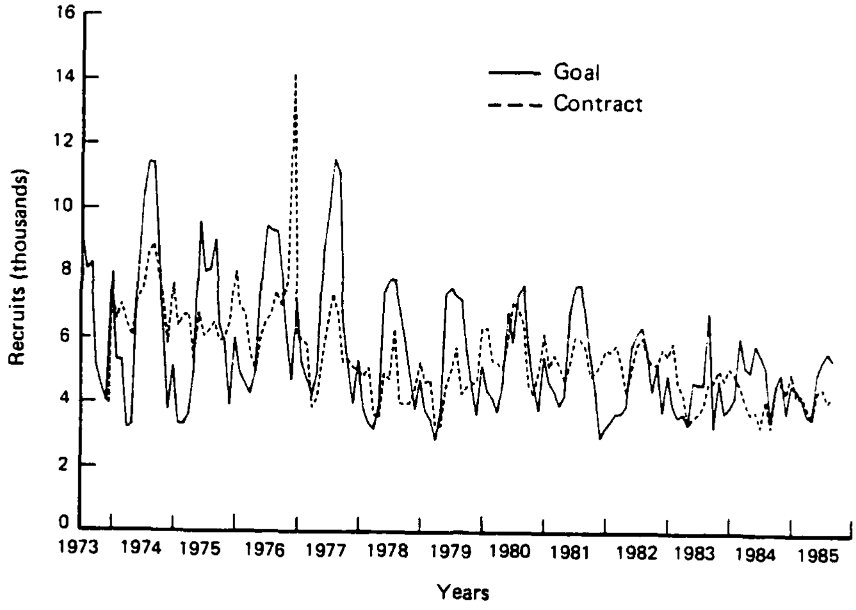

FIG. 1: ACCESSION GOAL AND CONTRACTS – USN NON-PRIOR-SERVICE MALES

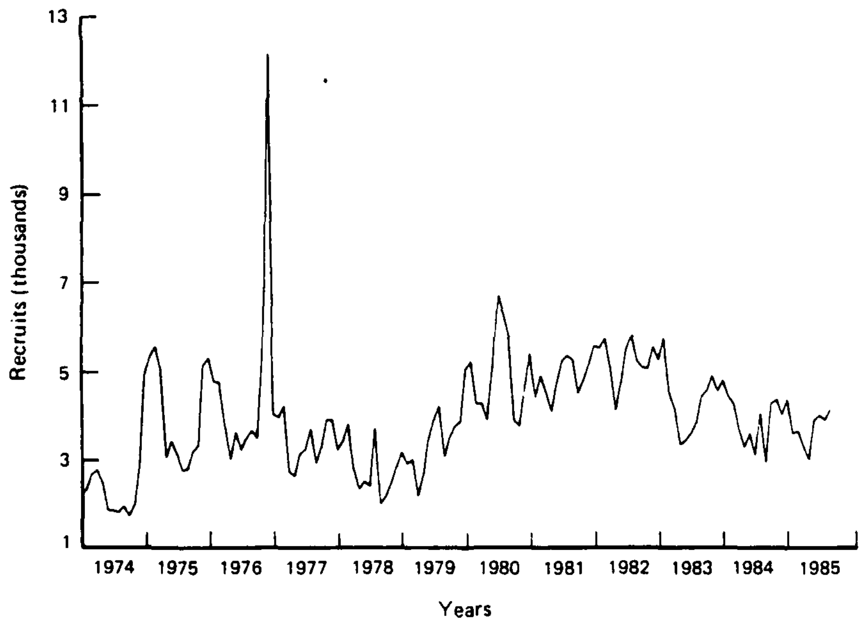

FIG. 2: ADDITIONS TO DEP (ADJUSTED) – USN NON-PRIOR-SERVICE MALES

for first differencing of these series, along with possible seasonal differencing to eliminate trends in the month-to-month or year-to-year value of the series. The accession goal series has a variance that declines over time as the accession goal falls. To reduce this change in the variance over time, the models for accession goal use the logarithm of accession goal as the dependent variable. The results can be interpreted in terms of percentage changes per unit of time, or can be transformed back to the original units, being careful to account for the fact that the expectation of $\log(Z_t)$ is $\exp(\mu + 1/2\ \sigma^2)$, where $\log(Z_t)$ is distributed as $N(\mu, \sigma^2)$. The most common seasonal ARIMA models are multiplicative in seasonal and nonseasonal components, and the search for a good ARIMA model of each series begins with the exploration of seven such common models for each series. Table A-8 of the appendix lists these models, none of which provides the best fit for any of the series.

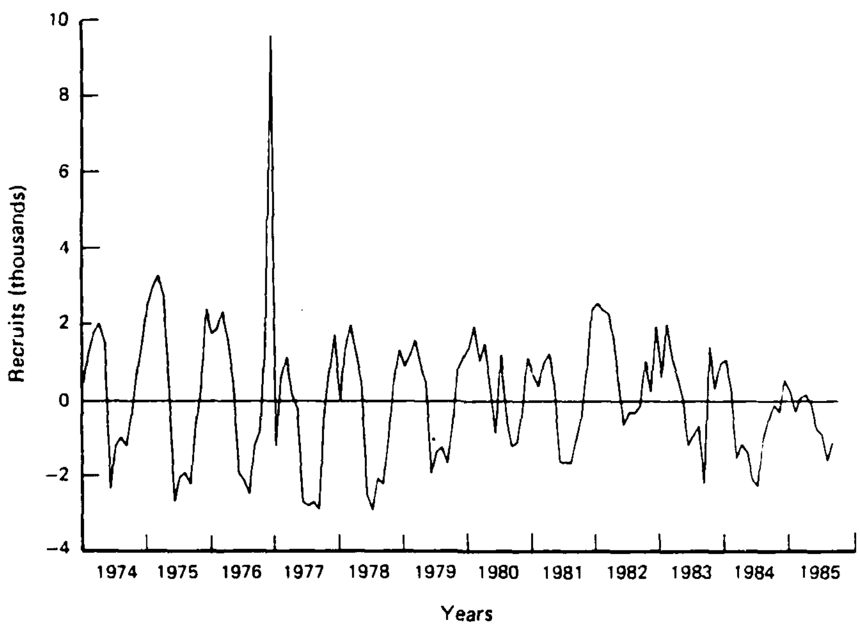

FIG. 3: CHANGE IN DEP – USN NON-PRIOR-SERVICE MALES

The final estimated model for each series is presented in tables 2 through 5. Each series is differenced, first with a lag of one month, then with a lag of 12 months. For the transformed series, estimated autocorrelation and partial autocorrelation functions used in the identification stage are presented as characteristics of the series. The final estimated model is presented in standard format with

TABLE 2

ARIMA MODEL OF USN NPS MALE ACCESSION GOAL

Transformation Statistics

Degrees of differencing = 1, 12 $\quad \bar{W} = 0.007 \quad \dot{s}_W = 0.209$ $\quad$ Transformation: $\log(Z_t) = W_t$ $\quad n = 128$

Estimated Autocorrelation Function: W_t

Lag												
1-12	-.20	-.11	.04	-.18	-.03	-.09	-.01	.23	-.09	.08	.18	-.45
	(.088)[a]	(.092)	(.093)	(.093)	(.096)	(.096)	(.096)	(.096)	(.101)	(.101)	(.102)	(.104)
13-24	.07	.03	-.01	.08	-.01	.13	.04	-.19	.05	.00	.00	.02
	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)

Estimated Partial Autocorrelation Function: W_t

Lag												
1-12	-.20	-.16	-.02	-.20	-.12	-.21	-.13	.12	-.07	.05	.19	-.36
13-24	-.07	-.04	.01	-.04	-.01	.02	.03	-.01	-.02	.06	.21	-.14

$\dot{s} = .088$

Final Estimated Model[b]

$$\underset{(-2.23)}{(1 + .326B^{12})}W_t = (1 - \underset{(1.71)}{.141B} + \underset{(-2.06)}{.173B^{11}} - \underset{(3.67)}{.507B^{12}})a_t$$

$$\dot{s}_{\dot{a}} = 0.161$$

$$x^2(13) = 13.32\ (P = 0.42)$$
$$x^2(19) = 13.64\ (P = 0.81)$$

a. Approximate standard errors in parentheses. Standard errors for the partial autocorrelation function are the same as lag 1 of the autocorrelation function.
b. t-statistics in parentheses below coefficients.

TABLE 3

ARIMA MODEL OF USN NPS MALE ADDITIONS TO DEP (ADJUSTED)

Transformation Statistics

Degrees of differencing = 1,12 $\quad$ Transformations: None

$\bar{W} = -12.0 \quad \dot{s}_W = 1{,}430.5 \quad n = 128$

Estimated Autocorrelation Function: W_t

Lags												
1-12	-.37	-.10	.08	-.10	.01	.02	.00	-.02	.00	-.01	.27	-.34
	(.088)[a]	(.10)	(.10)	(.10)	(.10)	(.10)	(.10)	(.10)	(.10)	(.10)	(.10)	(.11)
13-24	.03	.10	-.03	-.02	.01	.02	-.18	.21	-.03	.01	.01	-.09
	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)

Estimated Partial Autocorrelation Function: W_t

Lags												
1-12	-.37	-.28	-.09	-.16	-.12	-.09	-.04	-.07	-.06	-.07	.31	-.13
13-24	-.10	-.04	.06	-.05	-.06	.00	-.21	.04	.00	.03	.19	-.04

Final Estimated Model[b]

$$W_t = (1 - \underset{(6.92)}{.507B} - \underset{(5.51)}{.417B^{12}})a_t - \underset{(-.05)}{8.9}$$

$$\dot{s}_{\dot{a}} = 1{,}160.3$$

$$x^2(15) = 14.02 \ (P = .52)$$
$$x^2(21) = 23.44 \ (P = .32)$$

a. Approximate standard errors in parentheses. Standard errors for the partial autocorrelation function are the same as lag 1 of the autocorrelation function.

b. t-statistics in parentheses below coefficients.

TABLE 4

ARIMA MODEL OF USN NPS MALE NET CONTRACTS

Transformation Statistics

Degrees of differencing = 1.12   Transformations: None

$\bar{W} = 5.80$ $\dot{s}_W = 1{,}588.0$ $n = 128$

Estimated Autocorrelation Function: W_t

Lag												
1-12	-.44 (.088)[a]	.04 (.10)	.04 (.10)	-.17 (.10)	.05 (.11)	-.09 (.11)	.04 (.11)	.02 (.11)	.08 (.11)	-.03 (.11)	.26 (.11)	-.38 (.11)
13-24	.08 (.12)	-.02 (.12)	-.01 (.12)	-.02 (.12)	-.02 (.12)	.16 (.12)	-.14 (.12)	.22 (.13)	-.16 (.13)	.01 (.13)	-.06 (.13)	-.05 (.13)

Estimated Partial Autocorrelation Function: W_t

Lag												
1-12	-.44	-.19	-.03	-.20	-.15	-.21	-.14	-.11	.03	-.01	.36	-.11
13-24	-.12	-.13	.05	-.16	-.17	-.04	-.15	.07	-.01	-.02	.06	-.09

Final Estimated Model[b]

$$\underset{}{(1 - \underset{(1.96)}{.158B} + \underset{(-7.34)}{.584B^{12}} + \underset{(-5.80)}{.446B^{24}})W_t} = (1 - \underset{(13.35)}{.815B})a_t + \underset{(.15)}{1.6}$$

$$\dot{s}_{\dot{a}} = 1{,}139.6$$

$$x^2(13) = 17.24 \ (P = .19)$$
$$x^2(19) = 27.34 \ (P = .10)$$

a. Approximate standard errors in parentheses. Standard errors for the partial autocorrelation function are the same as lag 1 of the autocorrelation function.
b. t-statistics in parentheses below coefficients.

TABLE 5

ARIMA MODEL OF USN NPS MALE CHANGE IN DEP

Transformation Statistics

Degree of differencing = 1, 12 — Transformations: None

$\bar{W} = -20.7$ $\quad \dot{s}_W = 1{,}760.9$ $\quad n = 128$

Estimated Autocorrelation Function: W_t

Lag												
1-12	-.43	-.10	.18	-.19	.02	.06	-.06	.09	-.13	.09	.21	-.36
	(.088)[a]	(.10(	.10)	(.11)	(.11)	(.11)	(.11)	(.11)	(.11)	(.11)	(.11)	(.12)
13-24	.07	.07	-.08	.06	.03	.01	-.11	.06	.04	-.04	.07	-.10
	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)	(.13)	(.13)	(.13)	(.13)	(.13)

Estimated Partial Autocrrelation Function: W_t

Lag												
1-12	-.43	-.35	-.04	-.19	-.15	-.10	-.10	.01	-.16	.-04	.28	-.09
13-24	-.17	-.16	-.04	-.08	-.07	.03	-.14	-.04	-.09	-.04	.22	-.04

Final Estimated Model[b]

$$\underset{(-3.30)}{(1 + .323B^{12})}W_t = (1 - \underset{(11.21)}{.846B} - \underset{(2.06)}{.136B^{12}})a_t - \underset{(-.34)}{2.05}$$

$$\dot{s}_{\dot{a}} = 1{,}294.5$$

$$x^2(14) = 12.43 \ (P = .57)$$
$$x^2(20) = 22.95 \ (P = .29)$$

---

a. Approximate standard errors in parentheses. Standard errors for the partial autocorrelation function are the same as lag 1 of the autocorrelation function.

b. t-statistics in parentheses below coefficients.

autoregressive terms (W_t) on the left-hand side and moving average terms (a_t) on the right-hand side. The operator B^i denotes the ith lag of either W_t or a_t. Finally, the χ^2 statistics are provided for the Ljung and Box test statistic for overall autocorrelation of model residuals, computed up to the lag value in parentheses. High probability values for these statistics accept the null hypothesis of no autocorrelation.

The structures of the final models for accession goal and change in DEP are similar, the difference being the absence of a moving average term with an 11-month lag in the change in DEP series. When introduced, such a term in the change in DEP model is statistically insignificant and does not substantially alter the pattern of residual autocorrelations. The models for additions to DEP and net contracts are significantly different from each other and from the other two series. The adequacy of the models can be judged from the χ^2 test of autocorrelation among the model residuals. All the models are adequate at the usual confidence levels. The model of accession goal has the highest level of confidence regarding the absence of residual autocorrelation, as might be expected from a managed series. The models of change in DEP and additions to DEP share some of this predictability, though each series is strongly influenced by the contracts series that, on the χ^2 test of autocorrelation of residuals, fits least well. The contracts model also distinguishes itself by length of the autoregressive lag--a 24-month lag appears in the final estimated model.[1]

Within-sample and forward forecasts of these series are presented in table 6. The forecasts from October 1984 to September 1985 are multistep, i.e., the forecast for the next period is based on the forecasts for all previous periods, with a base period of September 1984. None of the series are predicted very well within-sample by the estimated models. One message that is consistent across the models, however, is that recruiting performance was better in FY 1985 than these models predicted on the basis of the previous 12 to 24 months. Additions to DEP and contracts uniformly exceed the forecasts, and changes in DEP are more positive than predicted in 10 of the first 12 months. Because the standard errors of the forecasts are large, virtually all actual values are within 1.6 standard deviations of the point forecast.

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1. Despite the apparent similarity in estimated autocorrelation and partial autocorrelation functions for additions to DEP and net contracts, the model fitted for additions to DEP could not be made to converge when applied to the net contracts series.

TABLE 6

FORECASTS OF ARIMA MODELS[a]

Year-month	Contracts Forecast	Contracts Actual	Adjusted additions to DEP Forecast	Adjusted additions to DEP Actual	Change in DEP Forecast	Change in DEP Actual
84-10	3,640	4,583	3,215	4,300	481	-108
84-11	3,896	4,737	3,063	4,380	-552	-298
84-12	3,924	4,395	2,800	4,038	563	542
85-1	4,307	5,069	2,999	4,376	201	269
85-2	4,246	4,276	2,949	3,624	324	-296
85-3	4,063	4,367	2,693	3,673	-863	86
85-4	3,558	3,967	2,212	3,325	-588	159
85-5	2,880	3,614	1,741	3,026	-833	-86
85-6	3,225	4,461	2,037	3,918	-1,723	-723
85-7	3,423	4,599	1,995	4,029	-1,710	-876
85-8	4,032	4,155	2,935	3,926	-895	-1,574
85-9	3,488	4,373	2,370	4,145	-1,299	-1,101
85-10	4,617	4,571	4,833	2,987	463	-178
85-11	4,585		4,579		-69	
85-12	4,590		4,097		708	
86-1	4,878		4,302		539	
86-2	4,648		3,772		-13	
86-3	4,177		3,802		-488	
86-4	3,697		3,386		-415	
86-5	3,084		2,976		-727	
86-6	3,489		3,559		-1,498	
86-7	3,479		3,446		-1,728	
86-8	3,494		3,661		-1,647	
86-9	3,863		3,710		-1,156	

a. Forecasts from 84-10 to 85-9 are multistep forecasts from 84-9. The forecast for 85-10 is a single-step forecast; beyond 85-10 are multistep forecasts with a base of 85-9.

Within-sample single-step forecasts, i.e., the forecasts for the next period, use all available data up to the present period, and their errors are generally more useful for making inferences about systematic deviations of recruiting performance from that predicted by the model, because these forecasts are available for the entire period. Table 7 summarizes, by fiscal year, single-step predictions for the DEP and contracts series. FY 1978 and FY 1983 have predicted contracts that exceed actual contracts by 3,942 and 6,939, respectively. FY 1978 is widely perceived to have presented a difficult recruiting environment, but FY 1983 is not.[1] FY 1980 has 8,368 more actual contracts than predicted. These ARIMA models do not fit the cyclic swings very well. Nevertheless, the multistep forecasts do have value as inputs to the X-11-ARIMA deseasonalization procedure to be described in the following section. The difference between actual values and the forecast values in table 6 can be considered deseasonalized versions of the series because the forecasts include imputations of past seasonal variation, and trends are included in the integration of the difference transformations.

TABLE 7

WITHIN-SAMPLE ALGEBRAIC SUM OF SINGLE-STEP FORECAST ERRORS[a]

Fiscal year	Contracts		Adjusted additions to DEP		Change in DEP	
	Residual	Actual	Residual	Actual	Residual	Actual
1977	442	80,999	-2,613	51,533	-4,371	75
1978	-3,942	58,076	-1,724	37,429	2,659	-2,360
1979	931	53,585	1,947	36,218	3,128	99
1980	8,368	69,055	4,354	57,836	3,037	6,394
1981	-765	64,053	-2,735	56,353	-5,094	-1,935
1982	-343	64,613	-221	62,028	5,235	10,734
1983	-6,939	56,371	-2,442	54,160	-2,848	2,742
1984	576	52,143	-909	48,324	-2,817	-5,694
1985	2,932	52,586	3,172	46,760	1,630	-4,006

a. Errors are from models estimated in tables 3, 4, and 5. Negative residuals indicate that actual values are less than predicted.

1. The FY 1983 overestimate is possibly due to a Navy policy that may have had the effect of discouraging contracts for DEP.

SMOOTHING APPROACH TO DESEASONALIZATION

The most commonly employed seasonal adjustment procedures use moving-average techniques to smooth the data. Among these, the X-11 program developed at the U.S. Census Bureau and described in [8] and [11] is the procedure used to produce official seasonally adjusted series for the U.S. Government. The procedure is flexible and can be implemented rather quickly. It incorporates several distinct moving averages in an iterative sequence that provide estimates of each of the unobserved components. The fundamental problem with the X-11 procedure is that computation of seasonal components at the end (beginning) of the observation period require data (for the moving averages) in the future (past) that are not directly observable. Seasonally accurate forecasts of the series for the next 12 months are thus required for accurate decomposition of the latest data observed. The Statistical Analysis System's (SAS) version of X-11 does not use such forecasts [11]. Most series to which X-11 is applied in this analysis are extended beyond the last observation by one year, with multistep ARIMA forecasts of the series based on the models in tables 2, 3, and 4.[1]

Assuming a multiplicative model and a yearly seasonal pattern, the X-11 procedure operates by first computing a centered 12-term moving average for the trend-cycle component and dividing the original series by this moving average to obtain the seasonal/irregular component. A month-specific moving average is then applied to this latter component to estimate the seasonal. A moving standard deviation is calculated from the irregular component and is used to weight extreme values in the seasonal and irregular components. New seasonal factors are estimated by applying a moving average to the modified series. Dividing the original series by these seasonal factors and applying a weighted moving average to the seasonally adjusted series yields a new trend-cycle component. The entire process is then repeated twice more, yielding final estimates of the trend-cycle, seasonal, and irregular components of the time series. For more detail on the individual steps, see [8 and 11].

Estimated seasonal factors from the X-11-ARIMA procedure are presented in table 8. Accession goal has a very strong seasonal pattern over the period, but the FY 1985 seasonal cycle is of much smaller amplitude than the average since 1974. The months of February, March, April, November, and December show steady increases in their seasonal component since at least 1978, with the biggest changes occurring in the 1981-through-1984 time period. All these months are part of the usual seasonal trough of this series. June, July, August, September, and October have witnessed steady declines of their high seasonal components since 1978 or 1979. With the exception of October, each of these months

---

1. Without some transformation to a series with all positive entries, the change in DEP series cannot be decomposed by this X-11 procedure.

maintains a high seasonal component but very much less so than in the period up to 1978.

The seasonal pattern of net contracts, as calculated by this method, is much less pronounced than that of accession goal, and the FY 1985 seasonality more closely resembles the average seasonality since 1974. Among the notable changes are the reductions of the seasonal components in June, July, August, and September and the increases in October, November, and February. This is likely indicative of a longer average stay in DEP in recent years, probably due in part to a favorable recruiting and retention environment.[1]

TABLE 8

X-11 ARIMA SEASONAL ADJUSTMENT FACTORS

	Accession goal		Net contracts		Adjusted additions to DEP	
Month	Average seasonal factor (1974-1985)	FY 1985 seas. factor	Average seasonal factor (1974-1985)	FY 1985 seas. factor	Average seasonal factor (1974-1985)	FY 1985 seas. factor
Jan	95.0	96.8	114.3	113.7	121.0	112.4
Feb	79.5	88.7	102.8	106.6	109.9	101.4
Mar	78.3	93.5	101.9	102.2	109.3	100.5
Apr	75.7	91.2	87.4	93.2	93.5	90.2
May	81.0	87.6	79.3	81.3	78.7	78.9
Jun	123.1	116.3	94.9	91.5	90.9	91.7
Jul	133.0	117.5	102.4	96.9	93.4	94.5
Aug	132.6	115.9	106.8	96.3	99.0	98.9
Sep	130.3	113.3	105.6	101.7	93.6	101.9
Oct	102.7	93.8	97.7	102.4	95.9	108.7
Nov	95.2	104.5	102.0	106.4	105.0	111.2
Dec	70.8	77.7	103.4	105.2	111.9	107.1

1. No direct evidence is available on this point, but figure A-1 (in the appendix) presents the trend-cycle component of an X-11 analysis of the size of the one-month DEP relative to the size of the six-month DEP as indirect evidence. Beginning in the fall of 1981 there was an unprecedented rise in the number of recruits in DEP scheduled to ship in 6 months. An equally precipitous decline began in the fall of 1983, a fact that correlates well with the beginning of the recent upturn in economic activity.

Additions to DEP have a seasonal amplitude and pattern similar to net contracts. The strong seasonal components associated with January, February, and March have been recently reduced or eliminated; the seasonal components associated with September, October, and November have increased. Given the seasonal pattern of accession goal, this change may be additional indirect evidence of a longer average stay in DEP.

The trend-cycle components of the net contracts and additions to DEP series are presented in figures 4 and 5. These series are expected to be inversely related to the civilian economic opportunities of young men.

The estimated trend-cycle component of net contracts is constructed as a weighted moving average of the deseasonalized version of the series. It shows a sharp decline in FY 1977 and FY 1978, followed by a sharp rise in FY 1980. The decline in FY 1983 coincides with the beginning of the current economic expansion in late 1982. This economic expansion is the second longest in post-World War II experience. The trend-cycle level of net contracts resembles very closely that of the FY 1978 and FY 1979 period, but has lasted nearly twice as long. In FY 1978 and FY 1979, the decline in net contracts is associated with not making accession goal. (Compare accession goal in table A-9 to the sum of reported shipments from DEP and direct shipments in tables A-1 and A-2.) In the more recent period, the result has been an undesired decline in the size and quality of the DEP (table 1), a matter of some concern to Navy manpower management. Notice that the recent downturn involved a less severe drop in additions to DEP than in the 1978-to-1979 period. The net effect is that relative to the earlier trough, FY 1984 had less than half the percentage of direct shipments in FY 1978.

The estimation of seasonal components by the X-11 procedure maintains the implicit assumption that the period of seasonal fluctuation is 12 months. The validity of this assumption is examined in the following section.

FREQUENCY DOMAIN APPROACH TO DESEASONALIZATION

In the course of addressing bias in time-series regression due to evolving seasonal "noise," [7] suggests a number of procedures to reduce the bias. One of these methods is a frequency domain (spectral) procedure in which the estimated seasonal bands are "zeroed out" and the series is transformed back to the time domain. This approach provides some new insights into the nature of the seasonal variation associated with these recuiting time series.

Spectral techniques are motivated in [2] and [13] by noting that lights of various colors or musical tones are "formed by a superposition of pure harmonics," which can be decomposed into a number of harmonic

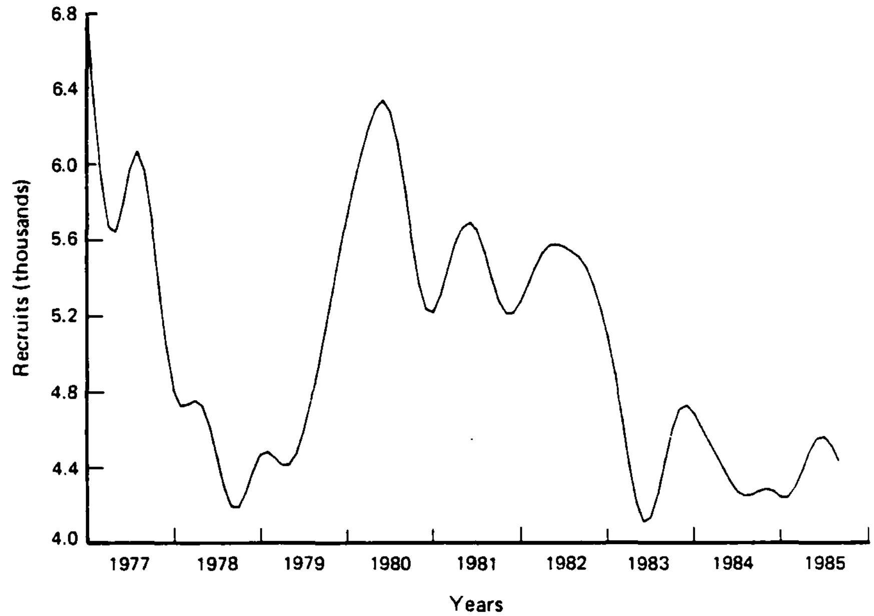

FIG. 4: CONTRACTS TREND-CYCLE

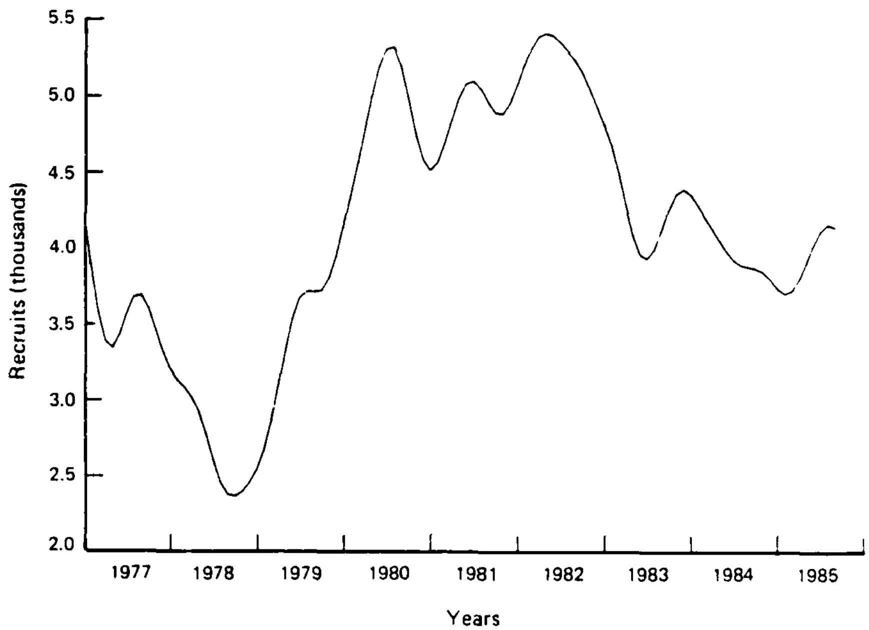

FIG. 5: ADDITIONS TO DEP TREND-CYCLE

functions with various frequencies, amplitudes, and phases. The spectral representation of a time series may be written as:

$$Z_t = \sum_{\lambda} (a_\lambda \cos \lambda t + b_\lambda \sin \lambda t) \qquad -\infty < t < \infty ,$$

where $a_\lambda = A_\lambda \cos \psi_\lambda$ and $b_\lambda = A_\lambda \sin \psi_\lambda$, and λ is the frequency of the harmonic, A_λ is its amplitude, and ψ_λ is its phase. The average power of a time series is defined in [13] as

$$\lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} Z^2(t)dt \quad ,$$

where $Z(t)$ is the observed time series. It is then shown in [13] that the various frequency components of a time series contribute additively to the average power. The function that relates power to frequency, showing the amount of power contributed at each frequency, is called the (power) spectrum of the series. To the extent that Navy policy and economic phenomena are associated with variations in the power of the series at different frequencies, the relative amount of power attributable to each can be determined from the spectrum. Once the spectrum is estimated, the power surrounding the seasonal frequencies is removed, producing a deseasonalized version of the series.[1]

Figures 6 and 7 depict the estimated spectra of accession goal, change in DEP, net contracts, and additions to DEP. As expected, the spectra of net contracts and additions to DEP are quite similar, as are those of accession goal and change in DEP. There are, however, major differences between the two sets of series. Table 9 presents the percent contributions to the cumulative spectral density by cycles of more than 4 years, annual cycles, and semiannual cycles. Accession goal and change in DEP are dominated by annual cycles, and net contracts and additions to DEP are dominated by long periods of about 4 years or more. Neither the contracts nor the additions to DEP series have a significant 12-month cycle, though the 6-month cycle for net contracts is relatively strong. Additions to DEP are more sensitive to the long cycles, i.e.,

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1. The estimation and deseasonalization procedures are implemented in [14]. The spectrum for each time series is calculated after detrending and tapering the time series. The detrending is accomplished by OLS regression of the series against time. A standard trapezodial taper is applied to both ends of the series to smooth the connection between the unpadded and padded parts of the series. The series is then Fourier transformed, multiplied by its complex conjugate, and scaled to obtain the periodogram. The periodogram is then smoothed to produce an estimate of the spectrum. Also see [15] for a general discussion of these techniques.

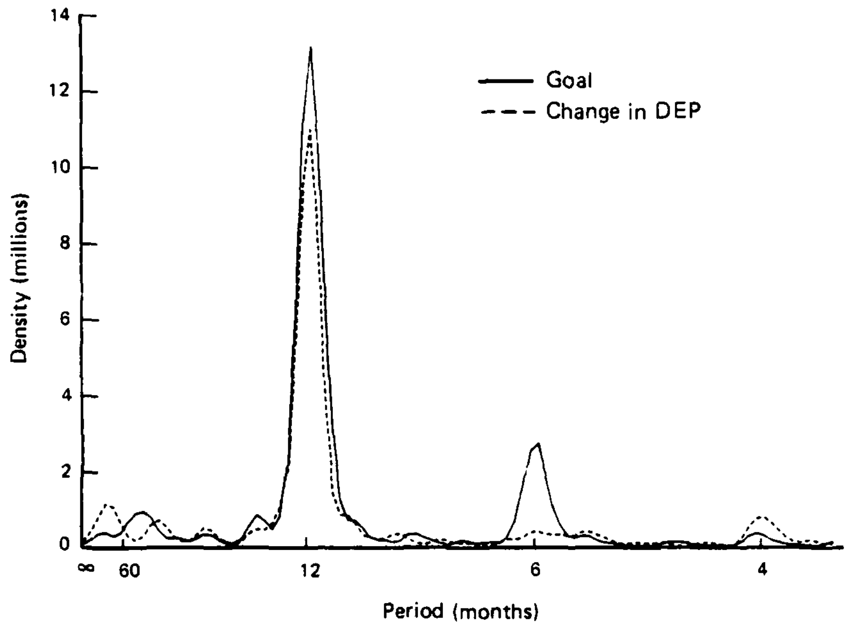

FIG. 6: SPECTRA OF RECRUITING SERIES — ACCESSION GOAL AND CHANGE IN DEP

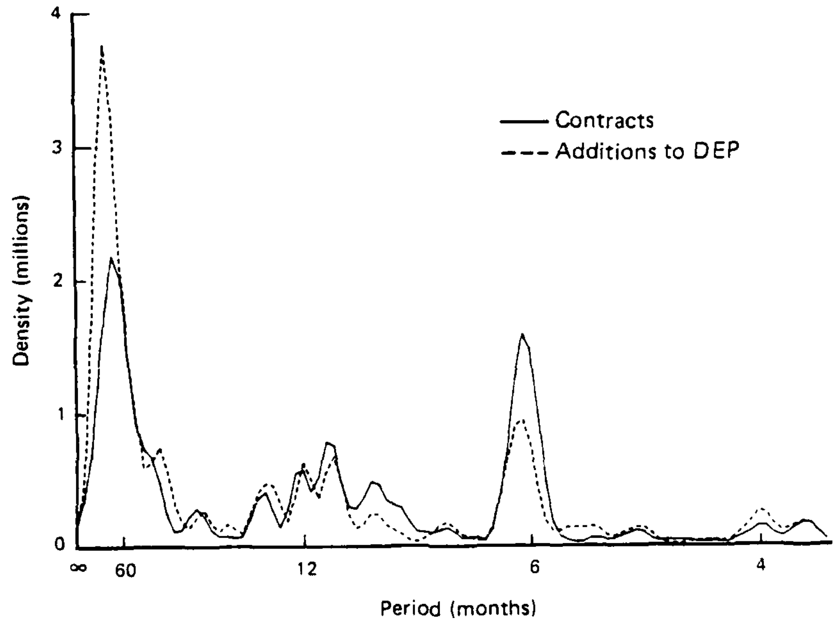

FIG. 7: SPECTRA OF RECRUITING SERIES — CONTRACTS AND ADDITIONS TO DEP

business cycles, than are contracts, and the annual and semiannual cycles in additions to DEP are relatively small.

TABLE 9

CONTRIBUTIONS TO VARIANCE BY COMPONENTS OF VARIOUS PERIODS: QUANTITY DATA

Periods in vicinity of	Accession goal (percent)	Change in DEP (percent)	Net contracts (percent)	Additions to DEP (percent)
$\geq$ 45 months	0	1	25	38
12 months	52	47	6	5
6 months	11	2	14	7

Plots of the X-11-ARIMA and spectral deseasonalizations are presented in figures 8 through 11. In figures 8 through 10, the solid line is produced by the X-11-ARIMA procedure, and the dotted line by the spectral procedure.

In the cases of accession goal and net contracts, the two techniques yield similar deseasonalized versions of the series in which month-to-month movements are highly correlated, but some values for individual months differ between the series by several hundred recruits. The frequency domain deseasonalization of change in DEP, which nets out the strong 12-month seasonal cycle, shows a period of increasing DEP in FY 1979 and FY 1980, followed by increasing DEP in FY 1982 and FY 1983 and a decline in the most recent 2-year period.

ANALYSIS OF ACCESSION QUALITY INDICATORS

Table 1 emphasizes the trade-off between the number and quality of USN NPS male recruits. Two quality indicators analyzed here are AFQT Categories I and II accessions as a percentage of total USN NPS male accessions, and high school diploma (HSD) accessions as a percentage of USN NPS male accessions. Figures 12 and 13 present plots of these series. Spectral analysis indicates that a large part of the variance is in seasonal bands of 12-month periods (HSD accessions also show a 6-month cycle).[1] Table 10 presents the contributions to spectral

1. Table A-10 presents an X-11 estimation of seasonal factors for percent HSD accessions. The largest difference in average seasonal factors between 1977 and 1985 is nearly 19 points. The largest such difference in 1985 is less than 15 points.

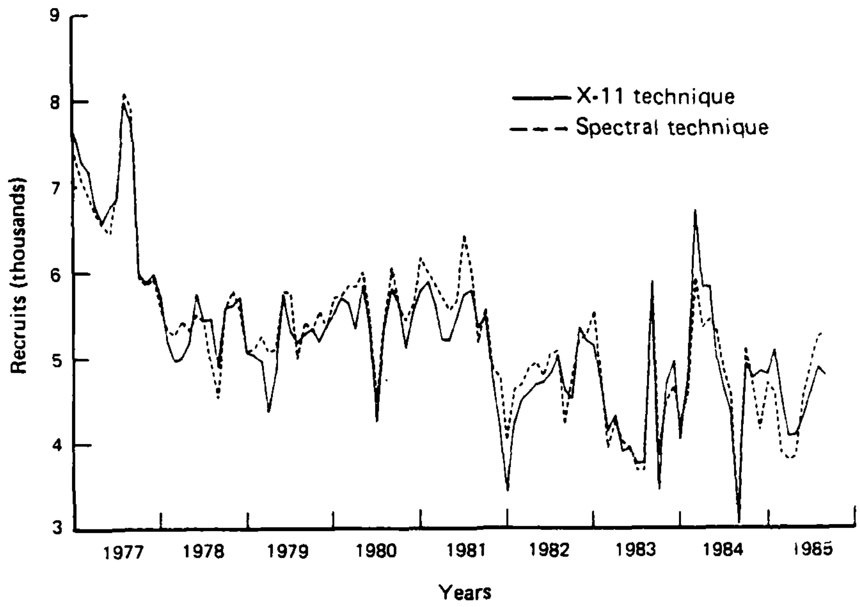

FIG. 8: DESEASONALIZED ACCESSION GOAL

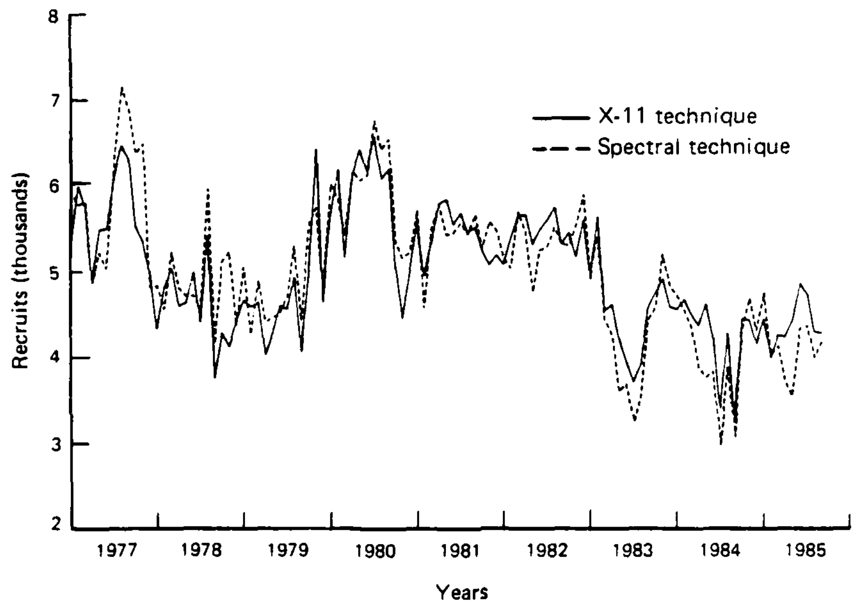

FIG. 9: DESEASONALIZED CONTRACTS

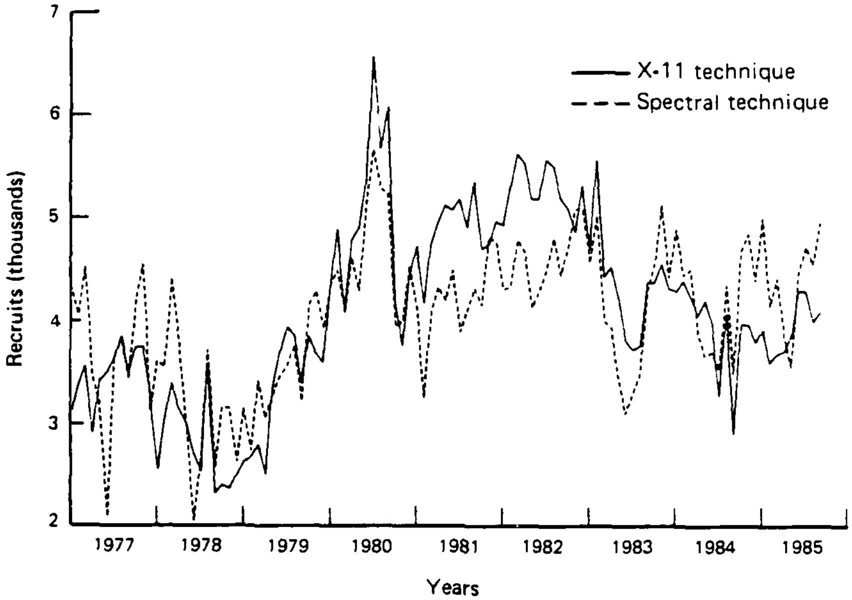

FIG. 10: DESEASONALIZED ADDITIONS TO DEP

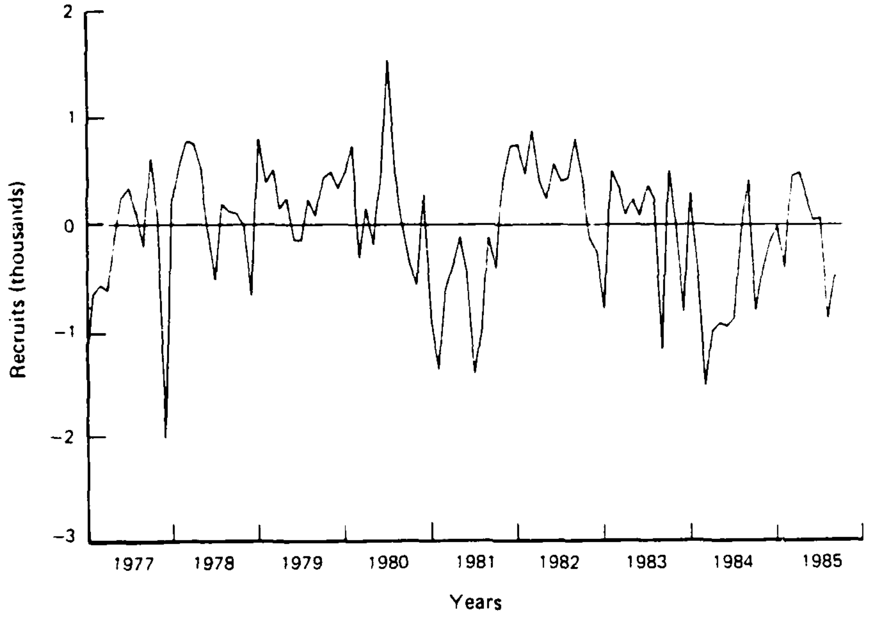

FIG. 11: DESEASONALIZED CHANGE IN DEP

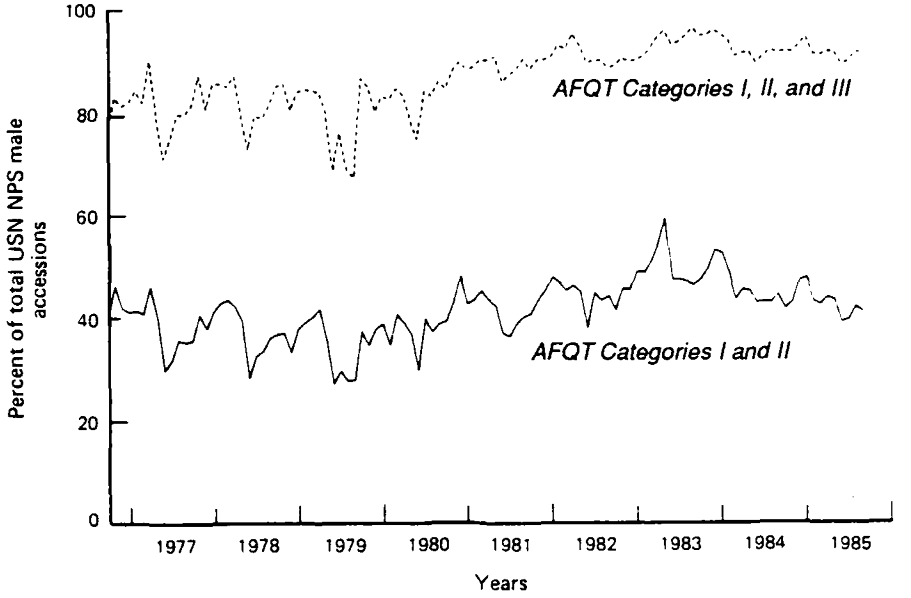

FIG. 12: AFQT CATEGORY COMPOSITION OF ACCESSIONS

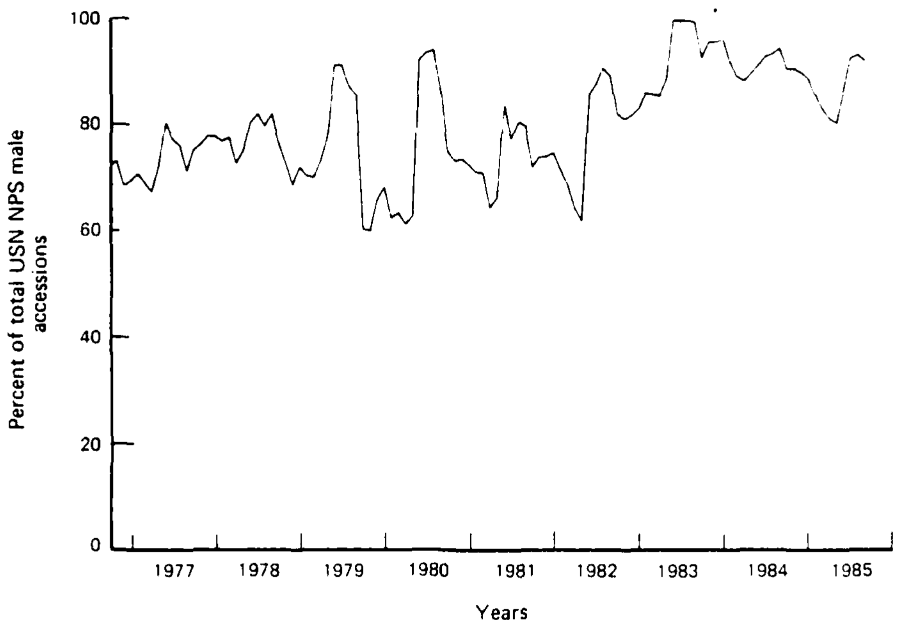

FIG. 13: ACCESSIONS WITH HIGH SCHOOL DIPLOMAS

density of frequencies in various ranges. The long cycles, 4 years or more, in AFQT Category I and II accessions account for about the same fraction of total variance as do the long cycles in additions to DEP, revealing its probable sensitivity to the business cycle. HSD accessions are apparently less sensitive to such long swings. The fact that HSD accessions approach 100 percent of total USN NPS male accessions is likely to introduce a truncation bias in the estimate of the spectrum for this series.

TABLE 10

CONTRIBUTIONS TO VARIANCE BY COMPONENTS OF VARIOUS PERIODS: QUALITY DATA

Periods in vicinity of	AFQT Category I and II accessions (percent)	HSD accessions (percent)
$\geq$ 48 months	39	22
12 months	25	34
6 months	3	15

X-11 and frequency domain deseasonalization of the AFQT Category I and II accession percentage is presented in figure 14. The X-11 trend-cycle estimate appears in figure 15. The remarkable rise in high AFQT accessions probably reflects the Navy's high elasticity of demand for this group as well as a potentially sensitive response of their supply to economic conditions.

COMPARISON OF THE TECHNIQUES

Among the four techniques explored, only the Census X-11 and frequency domain procedures are used to produce deseasonalized versions of the recruiting time series. The regression approach is not well suited to estimation of slowly evolving seasonal patterns as are observed in this data. The time-series (ARIMA) approach is not easily adapted to the unobserved components framework that underlies deseasonalization. In addition, the estimated ARIMA forecasts have relatively large confidence intervals and do not adequately predict cyclical turning points in the series. The forecasts are useful in improving the application of the standard Census X-11 procedure.

Conceptually, the frequency domain approach to deseasonalization seems preferable, because the spectral decomposition of the time series isolates seasonal cycles of all periods. By contrast, the Census X-11 procedure is designed to isolate annual cycles. This fact turns out to be of relatively little importance, since the seasonal cycles identified by the spectral procedure have frequencies that are harmonics (multiples of 1 or 2) of the annual cycle assumed by X-11. One potential drawback

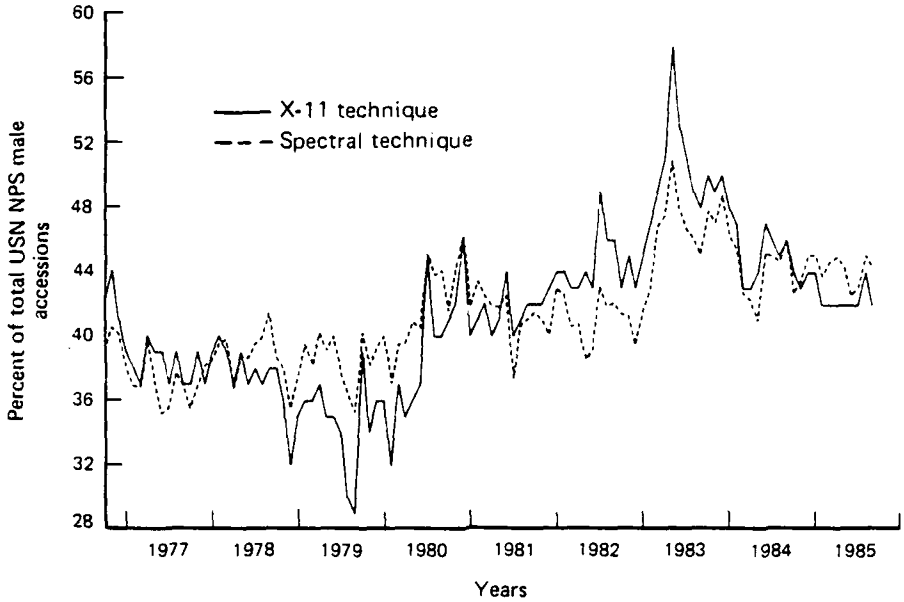

FIG. 14: DESEASONALIZED ACCESSIONS – AFQT CATEGORIES I AND II

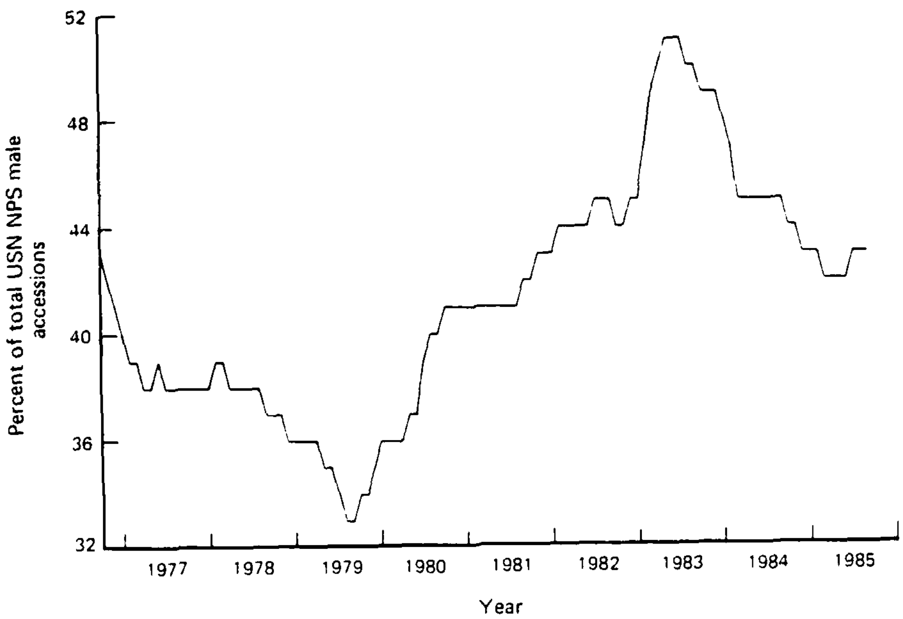

FIG. 15: TREND-CYCLE – AFQT CATEGORIES I AND II

of the spectral procedure is the need to detrend the series prior to analysis. Low-order polynomial functions of time may not adequately represent observed trends, with the result that the deseasonalized series deviates substantially from its "correctly" detrended value. Because of the widespread use of the Census X-11 procedure in deseasonalizing government statistics, it is a safe choice for the deseasonalization of Navy recruiting data.

CONCLUSION

Strong seasonal components of annual and semiannual periods are associated with Navy recruiting of USN NPS males. The seasonal cycles are found in both the number and quality of recruits. Attempts to quantify the seasonality show that the seasonal patterns have evolved over the period of the All-Volunteer Force, indicating that flexible procedures like X-11-ARIMA and frequency domain deseasonalization are desirable. The results of the two deseasonalization procedures are similar in their month-to-month movements but do contain some significant differences in magnitudes. The deseasonalized series can be employed in econometric studies of the impact of Navy recruiting resources on the quantity and quality of USN NPS male recruits.

Spectral analysis of the series indicates that additions to DEP and percent AFQT Category I and II accessions are characterized to a greater extent by fluctuations over a long period than are net contracts. The relative long-period dominance in additions to DEP appears to be due as much to a reduction of accession goal as to an increase in contracts. Increased retention and relatively constant force size may be the keys to this behavior because generally a favorable recruiting climate is also a favorable retention environment. As examination of figure 1 reveals, the unprecedented rise in additions to DEP between late 1981 and early 1983 reflects an unchanged but high rate of contract attainment (relative to FY 1985) and a significant decline in accession goal, with an implied longer average length of time in DEP. Mental group 1 and 2 accessions are also more sensitive to long-period fluctuations than are contracts. This is primarily an accession phenomenon, with the Navy selecting higher AFQT Category recruits during favorable cyclical recruiting periods. These facts suggest that AFQT Category I and II accessions may provide a more sensitive barometer of the cyclical recruiting environment than net contracts, without the complications associated with the additions-to-DEP variable.

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APPENDIX

RECRUITING DATA AND ANALYTICAL RESULTS

APPENDIX

RECRUITING DATA AND ANALYTICAL RESULTS

This appendix contains tables and figures referred to in the text.

TABLE A-1

USN NPS MALE RECRUITS: SHIPMENTS FROM DEP

EXPECTED SHIPMENTS

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	1,704	1,046	921	743	534	4,080	3,028	2,762	3,127	2,111	1,255	1,339
1975	2,381	2,333	2,267	2,275	2,545	5,883	5,138	4,857	5,005	3,853	3,028	2,762
1976	3,544	2,900	2,411	2,117	2,471	5,500	5,332	5,950	4,836	4,331	3,844	2,559
1977	5,224	3,344	3,084	2,581	2,859	5,819	6,021	6,372	5,790	3,617	3,149	2,189
1978	3,229	2,039	1,840	1,549	1,874	5,003	5,300	4,701	4,220	3,165	1,974	1,507
1979	2,263	1,738	1,532	1,463	1,768	4,825	4,358	4,365	4,146	3,496	2,258	1,972
1980	2,565	2,089	2,209	1,699	2,437	5,347	5,284	6,004	6,436	4,513	3,491	2,873
1981	3,759	3,118	3,020	2,423	3,011	5,891	5,732	5,952	5,669	4,362	3,763	2,770
1982	3,144	3,153	3,391	3,436	3,677	5,266	5,585	6,028	5,114	4,234	4,885	3,633
1983	4,457	3,742	3,399	3,480	3,256	4,695	4,443	4,495	5,896	3,049	4,272	3,442
1984	3,717	4,146	5,793	4,831	4,646	5,666	5,371	5,057	3,453	4,408	4,678	3,496
1985	4,107	3,920	3,587	3,166	3,112	4,641	4,905	5,408	5,147			

REPORTED SHIPMENTS

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	1,705	1,050	877	743	956	4,180	3,028	2,762	3,127	2,111	1,255	1,339
1975	2,381	2,333	2,267	2,275	2,545	6,077	5,130	4,657	5,005	3,853	3,028	2,762
1976	3,544	2,900	2,411	2,117	2,471	5,500	5,332	5,950	4,836	4,331	3,844	2,559
1977	5,224	3,344	3,084	2,581	2,859	5,819	6,021	6,372	5,790	3,617	3,149	2,189
1978	3,229	2,039	1,840	1,549	1,874	5,003	5,300	4,701	4,220	3,165	1,974	1,507
1979	2,263	1,738	1,429	1,275	2,173	5,404	5,258	5,437	4,747	4,185	3,840	2,727
1980	3,689	3,268	3,245	2,780	3,572	5,908	5,485	6,669	6,973	4,997	4,053	3,513
1981	4,683	4,053	3,910	3,297	3,680	8,372	6,851	7,006	6,341	4,994	4,047	2,758
1982	3,023	3,160	3,462	3,420	3,669	5,388	5,841	6,144	5,388	4,074	4,835	3,605
1983	4,632	3,742	3,419	3,539	3,296	4,587	4,510	4,522	6,630	3,159	4,586	3,693
1984	2,946	3,265	2,577	3,789	3,471	3,932	3,749	3,842	2,451	3,359	3,497	2,588
1985	3,167	3,100	2,853	2,547	2,387	3,004	3,414	5,500	5,285			

TABLE A-2

USN NPS MALE RECRUITS: DIRECT SHIPMENTS

REPORTED SHIPMENTS

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	5,203	4,250	4,374	3,667	3,528	5,320	5,604	6,809	6,960	6,135	5,330	2,942
1975	2,763	1,032	1,142	1,719	2,292	3,369	2,933	3,479	3,684	2,731	2,685	1,363
1976	2,785	2,205	2,043	1,810	1,942	2,423	3,289	3,266	3,782	3,524	2,429	2,071
1977	2,052	2,019	1,601	1,151	1,537	2,306	3,190	3,700	3,886	1,992	1,447	1,224
1978	1,760	1,424	1,314	880	1,202	2,430	2,348	2,606	2,020	1,803	1,586	1,657
1979	2,126	1,753	1,744	1,116	669	1,049	1,097	1,553	1,214	1,016	889	807
1980	1,307	1,136	1,059	1,008	1,168	919	472	702	726	731	532	404
1981	804	741	638	697	617	509	851	683	493	368	212	112
1982	124	110	109	160	196	316	312	273	293	160	187	200
1983	256	202	190	192	90	160	162	147	265	177	224	220
1984	1,151	1,380	3,571	1,472	1,632	2,004	1,872	1,380	1,394	1,322	1,538	1,265
1985	1,633	1,472	1,428	1,261	1,313	2,180	2,061	229	228			

ADJUSTED SHIPMENTS

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	5,203	4,250	4,374	3,667	3,528	5,320	5,604	6,809	6,960	6,135	5,330	2,942
1975	2,763	1,032	1,142	1,719	2,292	3,369	2,933	3,479	3,684	2,731	2,685	1,363
1976	2,785	2,205	2,043	1,810	1,942	2,423	3,289	3,266	3,782	3,524	2,429	2,071
1977	2,052	2,019	1,601	1,151	1,537	2,306	3,190	3,700	3,886	1,992	1,447	1,224
1978	1,760	1,424	1,314	880	1,202	2,430	2,348	2,606	2,020	1,803	1,586	1,657
1979	2,126	1,753	1,744	1,116	669	1,049	1,097	1,553	1,214	1,016	889	807
1980	1,307	1,136	1,059	1,008	1,168	919	472	702	726	731	532	404
1981	804	741	638	697	617	509	851	683	493	368	212	112
1982	124	110	109	160	196	316	312	273	293	160	187	200
1983	256	202	190	192	90	160	162	147	265	177	224	220
1984	380	499	355	430	457	270	250	165	392	273	357	357
1985	693	652	694	642	588	543	570	229	228			

TABLE A-2 (Continued)

REPORTED

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	2,197	2,327	2,669	2,771	2,487	1,885	1,846	1,807	1,942	1,730	1,971	2,876
1975	4,920	5,322	5,561	5,050	3,052	3,417	3,125	2,763	2,807	3,193	3,325	5,152
1976	5,303	4,778	4,752	3,756	3,018	3,613	3,240	3,487	3,674	3,498	5,262	12,156
1977	4,034	3,967	4,220	2,738	2,644	3,139	3,245	3,695	2,935	3,302	3,920	3,909
1978	3,235	3,433	3,813	2,798	2,352	2,520	2,418	3,710	2,019	2,179	2,478	2,839
1979	3,173	2,931	3,018	2,205	2,665	3,491	3,920	4,217	3,102	3,536	3,781	3,883
1980	5,072	5,226	4,288	4,278	3,922	5,069	6,709	6,285	5,787	3,900	3,783	4,643
1981	5,390	4,439	4,910	4,532	4,110	4,749	5,247	5,369	5,281	4,528	4,810	5,170
1982	5,594	5,542	5,749	5,105	4,151	4,763	5,541	5,826	5,249	5,106	5,077	5,561
1983	5,276	5,751	4,515	4,162	3,351	3,452	3,605	3,850	4,454	4,579	4,909	4,576
1984	4,028	3,575	1,068	2,650	2,134	1,866	1,492	2,835	1,954	3.251	3,199	3,130
1985	3,436	2,804	2,939	2,706	2,301	2,281	2,538	3,926	4,145			

ADJUSTED

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	2,197	2,327	2,669	2,771	2,487	1,885	1,846	1,807	1,942	1,730	1,971	2,876
1975	4,920	5,322	5,561	5,050	3,052	3,417	3,125	2,763	2,807	3,193	3,325	5,152
1976	5,303	4,778	4,752	3,756	3,018	3,613	3,240	3,487	3,674	3,498	5,262	12,156
1977	4,034	3,967	4,220	2,738	2,644	3,139	3,245	3,695	2,935	3,302	3,920	3,909
1978	3,235	3,433	3,813	2,798	2,352	2,520	2,418	3,710	2,019	2,179	2,478	2,839
1979	3,173	2,931	3,018	2,205	2,665	3,491	3,920	4,217	3,102	3,536	3,781	3,883
1980	5,072	5,226	4,288	4,278	3,922	5,069	6,709	6,285	5,787	3,900	3,783	4,643
1981	5,390	4,439	4,910	4,532	4,110	4,749	5,247	5,369	5,281	4,528	4,810	5,170
1982	5,594	5,542	5,749	5,105	4,151	4,763	5,541	5,826	5,249	5,106	5,077	5,561
1983	5,276	5,751	4,515	4,162	3,351	3,452	3,605	3,850	4,454	4,579	4,909	4,576
1984	4,799	4,456	4,284	3,692	3,309	3,600	3,114	4,050	2,956	4,300	4,380	4,038
1985	4,376	3,624	3,673	3,325	3,026	3,918	4,029	3,926	4,145			

TABLE A-3

USN NPS MALE DEPs

NUMBER IN DEP[a]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	3,113	5,073	6,922	7,615	10,583	8,156	6,972	6,020	4,307	3,926	4,642	6,179
1975	8,718	11,707	15,001	17,776	18,283	16,084	14,160	12,266	10,068	9,408	9,705	12,095
1976	13,854	15,732	18,073	19,674	20,242	18,355	16,263	13,800	12,638	11,805	13,223	22,820
1977	21,630	22,253	23,389	23,546	23,331	21,021	18,245	15,568	12,713	12,398	13,169	14,889
1978	14,895	16,289	18,262	19,511	19,989	17,506	14,624	12,554	10,353	9,367	9,871	11,203
1979	12,113	13,306	15,146	16,076	16,568	14,655	13,317	12,097	10,452	9,803	10,643	11,799
1980	13,182	15,140	16,183	17,681	18,031	17,192	18,416	18,032	16,846	15,749	15,479	16,609
1981	17,316	18,170	19,170	20,405	20,835	19,212	17,608	15,971	14,911	14,445	15,208	17,620
1982	20,191	22,573	24,860	26,545	27,027	26,402	26,102	25,784	25,645	26,677	26,919	28,875
1983	29,519	31,528	32,624	33,247	33,302	32,140	31,235	30,653	28,387	29,807	30,130	31,113
1984	32,195	32,505	30,996	29,857	28,520	26,454	24,197	23,190	22,693	22,585	22,287	22,829
1985	23,098	22,802	22,888	23,047	22,961	22,238	21,362	19,788	18,687			

CHANGE FROM PREVIOUS MONTH

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	492	1,277	1,792	2,028	1,531	-2,325	-1,182	-955	-1,185	-381	716	1,537
1975	2,539	2,989	3,294	2,775	507	-2,660	-2,005	-1,894	-2,198	-660	297	2,390
1976	1,759	1,878	2,341	1,639	547	-1,887	-2,092	-2,463	-1,162	-833	1,418	9,597
1977	-1,190	623	1,136	157	-216	-2,680	-2,776	-2,677	-2,855	-315	771	1,720
1978	6	1,394	1,973	1,249	478	-2,483	-2,882	-2,050	-2,201	-986	504	1,332
1979	910	1,193	1,589	930	492	-1,913	-1,338	-1,220	-1,645	-649	840	1,156
1980	1,383	1,958	1,043	1,498	350	-839	1,224	-384	-1,186	-1,097	-270	1,130
1981	707	386	1,000	1,235	430	-1,623	-1,604	-1,637	-1,060	-466	763	2,412
1982	2,571	2,382	2,287	1,685	482	-625	-300	-318	-139	1,032	242	1,956
1983	644	2,009	1,096	623	55	-1,162	-905	-672	-2,176	1,420	323	983
1984	1,082	310	-1,509	-1,139	-1,337	-2,066	-2,257	-1,007	-497	-108	-298	542
1985	269	-296	86	159	-86	-723	-876	-1,574	-1,101			

a. For the months of January 1974 through September 1974, the Navy data for number in DEP and change from previous month are inconsistent.

TABLE A-4

USN NPS MALE ACCESSIONS: PERCENT BY MENTAL GROUP

Year-Month	Mental group 1	Mental group 2	Mental group 3	Mental group 4
76-10	6.4	34.3	35.2	24.1
76-11	7.1	39.3	36.6	17.0
76-12	7.1	35.0	39.3	18.6
77-1	6.4	35.0	40.6	17.9
77-2	6.9	34.8	42.6	15.6
77-3	6.4	34.6	41.0	18.0
77-4	7.5	38.8	43.9	9.8
77-5	6.0	34.3	38.9	20.8
77-6	3.9	26.2	41.0	28.9
77-7	4.3	27.7	42.9	25.1
77-8	4.6	31.3	43.8	20.3
77-9	4.5	31.0	44.2	20.3
77-10	4.7	31.2	45.5	18.6
77-11	5.4	35.4	46.4	12.9
77-12	4.9	33.2	42.6	19.2
78-1	6.0	35.4	44.2	14.3
78-2	5.8	37.3	42.5	14.3
78-3	5.9	37.8	41.3	15.0
78-4	6.1	36.3	44.7	12.9
78-5	5.4	34.3	39.7	20.5
78-6	3.2	25.4	44.2	27.2
78-7	3.5	29.3	46.6	20.6
78-8	3.8	30.0	45.0	21.2
78-9	4.5	31.8	45.2	18.5
78-10	4.4	32.6	48.1	14.9
78-11	4.3	32.9	48.5	14.3
78-12	3.8	29.7	46.9	19.6
79-1	4.6	33.4	46.0	16.0
79-2	5.5	33.8	45.2	15.5
79-3	5.3	34.9	43.9	16.0
79-4	5.8	36.1	42.1	16.0
79-5	4.7	31.2	44.0	20.2
79-6	3.0	24.4	41.2	31.4
79-7	3.3	26.5	46.2	24.0
79-8	3.1	24.8	40.6	31.4
79-9	3.5	24.6	39.2	32.7
79-10	4.0	33.4	49.1	13.6
79-11	3.4	31.4	50.2	15.0
79-12	4.4	35.5	42.2	20.0
80-1	5.4	33.5	44.1	16.9
80-2	4.0	30.8	47.6	17.6
80-3	5.7	35.0	43.8	15.5

TABLE A-4 (Continued)

Year-Month	Mental group 1	Mental group 2	Mental group 3	Mental group 4
80-4	4.7	34.3	44.1	16.9
80-5	4.8	32.1	41.4	21.8
80-6	3.3	26.6	44.7	25.3
80-7	4.9	34.9	44.1	16.2
80-8	4.6	32.6	45.8	16.9
80-9	5.0	33.8	47.0	14.2
80-10	4.8	34.6	45.0	15.7
80-11	5.0	37.8	45.0	12.2
80-12	5.3	42.7	41.5	10.5
81-1	4.7	37.9	45.5	11.8
81-2	4.6	38.8	45.1	11.6
81-3	4.2	41.0	44.7	10.1
81-4	4.7	38.7	46.5	10.2
81-5	4.0	38.3	48.2	9.5
81-6	3.4	33.6	48.8	14.1
81-7	3.1	33.3	50.7	12.9
81-8	2.9	36.0	49.2	11.9
81-9	4.0	36.2	49.9	9.8
81-10	3.9	36.9	47.4	11.8
81-11	4.0	39.4	46.6	10.0
81-12	4.3	40.8	44.9	10.0
82-1	5.1	42.7	42.7	9.5
82-2	5.4	41.4	46.0	7.2
82-3	4.8	40.4	46.8	8.0
82-4	4.8	41.4	48.7	5.0
82-5	4.6	40.4	47.8	7.2
82-6	3.1	34.8	51.4	10.7
82-7	4.5	40.2	45.1	10.3
82-8	3.9	39.4	46.5	10.2
82-9	4.4	39.7	44.3	11.7
82-10	4.0	37.4	47.4	11.2
82-11	4.4	41.1	44.7	9.8
82-12	4.2	41.2	44.2	10.4
83-1	5.4	43.4	41.1	10.1
83-2	4.8	43.9	41.9	9.4
83-3	5.5	45.3	41.2	8.1
83-4	6.0	48.0	40.1	5.9
83-5	6.5	52.5	36.5	4.5
83-6	4.6	42.7	45.6	7.1
83-7	4.4	42.9	46.0	6.7
83-8	4.5	42.4	47.6	5.5
83-9	4.7	41.5	49.8	4.0
83-10	4.1	43.3	47.2	5.3

TABLE A-4 (Continued)

Year-Month	Mental group 1	Mental group 2	Mental group 3	Mental group 4
83-11	5.7	43.7	45.3	5.3
83-12	5.4	47.6	42.6	4.4
84-1	6.0	46.4	42.4	5.2
84-2	5.4	43.3	45.1	6.2
84-3	4.0	39.4	47.2	9.4
84-4	4.5	40.9	45.8	8.8
84-5	4.7	40.4	46.3	8.6
84-6	4.3	38.5	46.4	10.7
84-7	4.7	38.2	47.6	9.5
84-8	4.2	38.6	48.9	8.2
84-9	3.9	40.4	46.9	8.8
84-10	4.5	37.1	49.9	8.5
84-11	4.9	37.9	48.5	8.7
84-12	5.4	41.7	45.4	7.4
85-1	6.0	41.6	46.6	5.8
85-2	5.7	37.4	47.9	9.0
85-3	5.0	37.4	48.3	9.2
85-4	5.3	38.5	47.6	8.6
85-5	5.9	37.4	48.1	8.6
85-6	3.9	35.1	49.9	11.1
85-7	4.1	35.4	50.0	10.5
85-8	5.2	36.7	49.4	8.7
85-9	4.1	36.9	50.0	9.0

TABLE A-5

USN NPS MALE ACCESSIONS: TOTAL AND HIGH SCHOOL GRADUATES

Year-month	Accessions	High school diploma (percent)
76-10	7,855	72.4
76-11	6,293	73.3
76-12	4,630	68.7
77-1	7,276	69.6
77-2	5,363	70.9
77-3	4,685	69.3
77-4	3,732	67.5
77-5	4,396	72.2
77-6	8,125	80.3
77-7	9,211	77.4
77-8	10,072	76.2
77-9	9,676	71.4
77-10	5,609	75.4
77-11	4,596	76.5
77-12	3,413	78.0
78-1	4,989	77.9
78-2	3,463	77.0
78-3	3,154	77.7
78-4	2,429	72.8
78-5	3,076	75.0
78-6	7,433	80.5
78-7	7,648	82.1
78-8	7,307	79.8
78-9	6,240	82.1
78-10	4,968	76.7
78-11	3,560	72.9
78-12	3,164	68.8
79-1	4,389	72.1
79-2	3,491	70.5
79-3	3,173	70.2
79-4	2,391	73.3
79-5	2,842	77.7
79-6	6,453	91.3
79-7	6,355	91.3
79-8	6,990	87.4
79-9	5,961	85.7
79-10	5,201	60.5
79-11	3,840	60.1
79-12	3,534	66.0
80-1	4,996	68.3
80-2	4,404	62.6
80-3	4,304	63.6

TABLE A-5 (Continued)

Year-month	Accessions	High school diploma (percent)
80-4	3,788	61.5
80-5	4,740	62.8
80-6	6,827	92.3
80-7	5,957	93.6
80-8	7,371	94.1
80-9	7,699	86.7
80-10	5,728	74.9
80-11	4,585	73.3
80-12	3,917	73.7
81-1	5,487	72.6
81-2	4,794	71.3
81-3	4,548	71.0
81-4	3,994	64.6
81-5	4,297	66.4
81-6	6,881	83.6
81-7	7,702	77.5
81-8	7,689	80.6
81-9	6,834	79.8
81-10	5,362	72.2
81-11	4,259	74.0
81-12	2,870	74.2
82-1	3,147	74.8
82-2	3,270	71.6
82-3	3,571	68.8
82-4	3,580	64.4
82-5	3,864	62.1
82-6	5,704	85.7
82-7	6,153	87.6
82-8	6,417	90.7
82-9	5,681	89.4
82-10	4,234	82.0
82-11	5,022	81.2
82-12	3,805	81.9
83-1	4,888	83.2
83-2	3,944	86.1
83-3	3,609	85.8
83-4	3,731	85.6
83-5	3,386	88.7
83-6	4,747	99.9
83-7	4,672	99.7
83-8	4,669	99.8
83-9	6,895	99.3
83-10	3,336	92.7
83-11	4,810	95.7

TABLE A-5 (Continued)

Year-month	Accessions	High school diploma (percent)
83-12	3,913	95.8
84-1	4,097	96.1
84-2	4,645	91.8
84-3	6,148	89.1
84-4	5,261	88.3
84-5	5,103	89.8
84-6	5,936	91.3
84-7	5,621	92.9
84-8	5,222	93.5
84-9	3,845	94.4
84-10	4,681	90.6
84-11	5,035	90.7
84-12	3,853	89.9
85-1	4,800	88.9
85-2	4,572	85.7
85-3	4,281	83.0
85-4	3,808	81.2
85-5	3,700	80.4
85-6	5,184	86.5
85-7	5,475	92.6
85-8	5,729	93.3
85-9	5,513	92.2

TABLE A-6

GLOBALLY CONSTANT SEASONAL INDICATORS
OLS REGRESSION[a]

Independent variable	Accession goal	Contracts	Add to DEP	Ship from DEP
JA	92.04 (4.90)	111.27 (4.58)	115.09 (6.88)	92.56 (5.14)
FB	78.19 (4.90)	103.81 (4.58)	110.73 (6.88)	78.13 (5.14)
MR	78.50 (4.90)	101.58 (4.58)	109.38 (6.88)	76.49 (5.14)
AP	72.05 (5.14)	87.52 (4.80)	92.60 (7.21)	67.65 (5.39)
MY	80.47 (5.14)	79.11 (4.80)	78.43 (7.21)	75.51 (5.39)
JN	129.59 (5.14)	95.52 (4.80)	90.91 (7.21)	140.07 (5.39)
JL	134.06 (4.90)	102.01 (4.58)	93.62 (6.88)	139.16 (5.14)
AU	139.48 (4.90)	112.74 (4.58)	101.55 (6.88)	139.23 (5.14)
SP	137.66 (4.90)	103.95 (4.58)	88.47 (6.88)	132.49 (5.14)
OC	104.20 (4.90)	97.13 (4.58)	89.35 (6.88)	99.45 (5.14)
NV	93.72 (4.90)	99.05 (4.58)	98.37 (6.88)	88.27 (5.14)
DC	69.62 (4.90)	108.56 (4.58)	122.26 (6.88)	68.18 (5.14)
R^2	.74	.28	.24	.75

a. The dependent variable in these regressions is defined as a "ratio to moving average," i.e., the value for accession goal in month t is

$$G_t^* = \frac{G_t}{\sum_{t-6}^{t+5} G_i} \times 1{,}200 \ .$$

The coefficients reported in the table are thus interpreted as percentages of a yearly moving average. Numbers in parentheses are standard errors of the estimates. The period covered is July 1974 to March 1985.

TABLE A-7

TIME VARYING SEASONAL INDICATORS:
OLS REGRESSION[a]

Independent variable	Accession goal	Contracts	Add to DEP	Ship from DEP
JA	89.04 (7.57)	107.43 (9.39)	125.60 (13.27)	96.27 (8.79)
FB	60.57 (7.65)	95.81 (9.49)	123.74 (13.42)	67.85 (8.89)
MR	52.33 (7.74)	99.34 (9.60)	129.01 (13.58)	54.82 (8.99)
AP	48.76 (8.24)	79.78 (10.22)	99.70 (14.46)	45.63 (9.57)
MY	70.13 (8.34)	74.19 (10.34)	74.21 (14.63)	59.99 (9.67)
JN	145.22 (8.44)	102.27 (10.47)	87.89 (14.81)	169.33 (9.80)
JL	150.48 (7.06)	106.49 (8.75)	83.51 (12.38)	157.04 (8.19)
AU	162.36 (7.14)	118.93 (8.86)	84.33 (12.52)	151.47 (8.29)
SP	165.48 (7.22)	114.18 (8.96)	72.89 (12.67)	145.63 (8.39)
OC	120.31 (7.31)	95.62 (9.07)	68.32 (12.82)	104.52 (8.49)
NV	86.08 (7.39)	95.29 (9.17)	84.89 (12.97)	66.94 (8.59)
DC	58.22 (7.48)	117.01 (9.28)	149.18 (13.12)	55.15 (8.69)
Trend*JA	.045 (.099)	.058 (.123)	-.129 (.174)	-.056 (.115)
Trend*FB	.263 (.099)	.119 (.123)	-.194 (.174)	.153 (.115)

TABLE A-7 (Continued)

Independent variable	Accession goal	Contracts	Add to DEP	Ship from DEP
Trend*MR	.385 (.099)	.033 (.123)	-.289 (.174)	.319 (.115)
Trend*AP	.370 (.115)	.123 (.142)	-.113 (.201)	.350 (.133)
Trend*MY	.162 (.115)	.077 (.142)	.066 (.201)	.242 (.133)
Trend*JN	-.240 (.115)	-.104 (.142)	.046 (.201)	-.450 (.133)
Trend*JL	-.274 (.099)	-.075 (.123)	.169 (.174)	-.298 (.115)
Trend*AU	-.375 (.099)	-.101 (.123)	.282 (.174)	-.201 (.115)
Trend*SP	-.449 (.099)	-.165 (.123)	.251 (.174)	-.212 (.115)
Trend*OC	-.256 (.099)	.024 (.123)	.334 (.174)	-.080 (.115)
Trend*NV	.119 (.099)	.059 (.123)	.211 (.174)	.333 (.115)
Trend*DC	.175 (.099)	-.130 (.123)	-.414 (.174)	.200 (.115)
R^2	.86	.33	.37	.84
R^2	.83	.18	.23	.80
DW	1.41	1.57	1.47	1.21
Q	77.6	108.1	116.9	95.1
N	129	129	129	129

a. The dependent variable in these regressions is defined as a "ratio to moving average," i.e., the value for accession goal in month t is

$$G_t^* = \frac{G_t}{\sum_{t-6}^{t+5} G_i} \times 1{,}200 .$$

The coefficients reported in the table are thus interpreted as percentages of a yearly moving average. Numbers in parentheses are standard errors of the estimates.

TABLE A-8

COMMON SEASONAL ARIMA MODELS[a]

1.	$W_t = (1 - \Theta B^s)a_t$	$(0, d, 0)(0, D, 1)_s$
2.	$(1 - \Phi B^s)W_t = a_t$	$(0, d, 0)(1, D, 0)_s$
3.	$W_t = (1 - \theta B)(1 - \Theta B^s)a_t$	$(0, d, 1)(0, D, 1)_s$
4.	$(1 - \Phi B^s)W_t = (1 - \Theta B^s)a_t$	$(0, d, 0)(1, D, 1)_s$
5.	$(1 - \Phi B^s)W_t = (1 - \theta B)a_t$	$(0, d, 1)(1, D, 0)_s$
6.	$W_t = (1 - \theta_1 B - \theta_2 B^2)(1 - \Theta B^s)a_t$	$(0, d, 2)(0, D, 1)_s$
7.	$(1 - \Phi B^s)W_t = (1 - \theta B)(1 - \Theta B^s)a_t$	$(0, d, 1)(1, D, 1)_s$

a. From [7, p. 285]. Both common representations of each model are given. W_t is the transformed version of the series, including any differencing; a_t is a normally distributed random variable with mean zero and variance σ^2; and B is the backshift operator. Lowercase Greek symbols represent coefficients associated with "ordinary" backshift operators; uppercase Greek symbols represent coefficients associated with the seasonal backshift operator, B^s. In all the models estimated, $s = 12$. The right-hand column is simply an alternative notation for the model.

TABLE A-9

USN NPS MALE ACCESSION GOAL

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973	--	--	--	--	--	--	9,100	8,100	8,300	5,100	4,500	4,000
1974	8,000	5,300	5,300	3,200	3,300	8,000	10,400	11,436	11,450	8,593	6,466	3,763
1975	5,133	3,347	3,345	3,633	4,914	9,612	8,063	8,136	9,067	6,402	5,872	3,940
1976	6,005	4,943	4,631	4,293	4,936	7,765	9,480	9,344	9,311	7,873	6,160	4,713
1977	7,131	5,244	4,752	4,261	4,950	8,708	9,961	11,563	11,164	6,531	5,219	3,993
1978	5,343	3,820	3,399	3,212	3,904	7,477	7,863	7,831	6,931	6,016	4,909	3,852
1979	4,758	3,800	3,541	2,906	3,721	7,444	7,586	7,349	7,240	5,658	4,566	3,664
1980	5,202	4,423	4,212	3,769	4,607	6,870	5,839	7,421	7,713	5,803	4,613	3,825
1981	5,478	4,698	4,430	3,983	4,279	6,879	7,699	7,720	6,834	5,519	4,437	2,984
1982	3,303	3,498	3,748	3,763	3,961	5,792	6,200	6,419	5,682	4,438	5,221	3,804
1983	4,955	3,974	3,639	3,755	3,386	4,747	4,672	4,659	6,895	3,313	4,789	3,779
1984	3,942	4,239	6,117	5,227	5,070	5,901	5,581	5,210	3,548	4,658	5,004	3,792
1985	4,677	4,539	4,239	3,750	3,618	5,037	5,432	5,691	5,465			

DESEASONALIZED (X-11)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	8,542	7,497	8,280	5,132	4,376	6,519	7,184	7,764	7,605	7,624	7,032	5,940
1975	5,459	4,729	5,215	5,842	6,539	7,744	5,564	5,528	6,065	5,716	6,418	6,144
1976	6,414	6,961	7,155	6,877	6,581	6,127	6,527	6,390	6,316	7,125	6,816	7,201
1977	7,637	7,284	7,183	6,769	6,586	6,760	6,857	7,982	7,737	5,977	5,882	5,985
1978	5,716	5,197	4,973	5,012	5,165	5,748	5,436	5,461	4,907	5,595	5,621	5,715
1979	5,069	5,040	4,964	4,377	4,842	5,735	5,317	5,188	5,288	5,354	5,202	5,384
1980	5,526	5,706	5,648	5,349	5,850	5,343	4,268	5,364	5,818	5,631	5,127	5,553
1981	5,800	5,899	5,632	5,225	5,219	5,469	5,752	5,803	5,367	5,493	4,746	4,216
1982	3,454	4,243	4,526	4,611	4,708	4,734	4,828	5,020	4,628	4,533	5,356	5,210
1983	5,150	4,685	4,170	4,348	3,930	3,971	3,788	3,797	5,848	3,470	4,711	4,984
1984	4,069	4,858	6,742	5,848	5,842	5,016	4,656	4,384	3,086	4,964	4,790	4,871
1985	4,834	5,116	4,535	4,111	4,130	4,332	4,625	4,911	4,824			

TABLE A-10

X-11 SEASONAL FACTORS FOR PERCENT HIGH SCHOOL DIPLOMA

Month	Average since FY 1977	FY 1985
January	97.3	98.7
February	94.9	96.6
March	93.6	94.3
April	91.0	92.7
May	95.2	94.7
June	109.8	107.1
July	108.6	106.2
August	109.0	106.8
September	107.7	105.8
October	98.3	98.7
November	97.6	99.0
December	96.4	98.6

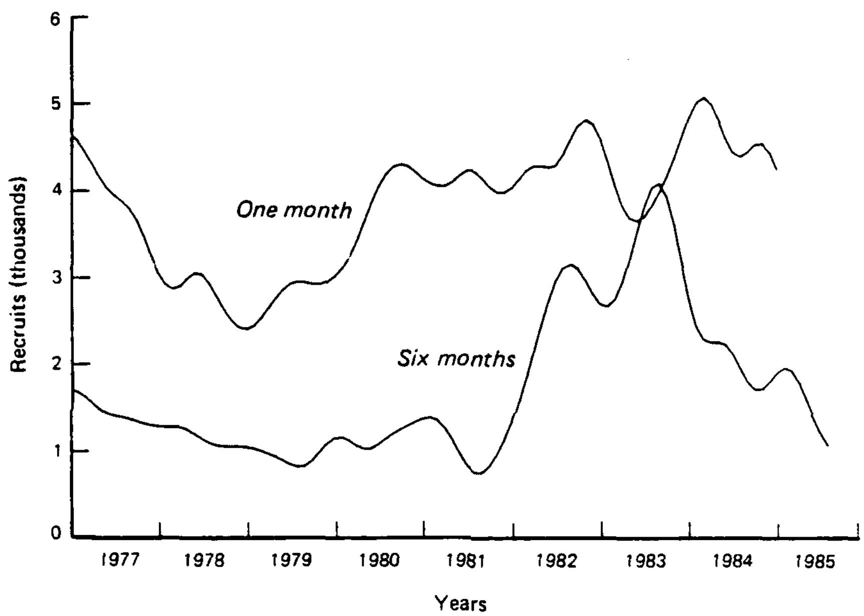

FIG. A-1: ONE-MONTH DEP vs. SIX-MONTH DEP: X11 TREND